This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LIFE IN THE PRIMEVAL WORLD

M. MEUNIER

LIFE IN THE PRIMEVAL WORLD.

IDEAL VIEW OF A MARSHY FOREST OF THE COAL PERIOD.

LIFE

IN

THE PRIMEVAL WORLD:

FOUNDED ON

MEUNIER'S "LES ANIMAUX D'AUTREFOIS."

By

W. H. DAVENPORT ADAMS,

Author of "Buried Cities of Campania," "Lighthouses and Lightships," "Queen of the Adriatic," &c. &c.

"In the beginning."—GENESIS.

BIBLIOTHECA BODLEIANA

LONDON:
T. NELSON AND SONS, PATERNOSTER ROW;
EDINBURGH; AND NEW YORK.

1872.

189. g. 118.

Preface.

WHEN I began this volume, it was with the intention of simply translating M. Meunier's work, "Les Animaux d'Autrefois." But I had scarcely entered upon the task before I found that something fuller, broader, and more detailed was required for the English reader; and hence I have been led to embody M. Meunier's small volume in the following manual, revising, expanding, curtailing, or adding entirely new material, as seemed to me desirable.

I hope that the result will secure the indulgence of the critic and the favour of the public; for I can honestly say that I have laboured hard in my vocation, and endeavoured to render my book as comprehensive and complete as its limits would permit.

I am not aware that any treatise on exactly the same plan has appeared in English; yet the plan is, in my humble opinion, well adapted for the student or for the general reader. To both it offers a synopsis of, and an index-hand to, a science of the highest interest and value, which is every day commanding more attention, and whose relations to some of the most interesting questions that await a philosophical solution cannot be disregarded. Paleontology is the sister of Geology, and the investigation of the one necessarily leads to the investigation of the other.

But Paleontology, be it remembered, is neither more nor less than the Natural History of the Primeval World; and for this reason it seemed proper that it should be set before the reader in accordance with the latest systems of modern naturalists.

A chapter on the Antiquity of Man has been added, in which the conclusions of the best authorities are stated, it is hoped, honestly and impartially.

W. H. D. A.

Contents.

INTRODUCTION, ... 13

BOOK I.—THE MAMMALS, ... 30

I.—QUADRUMANA : THE APES, ... 30

II.—THE CARNIVORA, ... 43
1. The Bears, ... 51
2. The Metarctos, ... 55
3. The Ictitherion, ... 57
4. The Hyenas, ... 59
5. The Great Cave-Tiger, and the Machairodus Cultridens, 63

III.—THE RODENTIA, ... 68
The Hystrix Primigenius, or Primitive Porcupine, .. 68

IV.—THE EDENTATA, ... 70
1. The Macrotherium, ... 71
2. The Ancylotherium, ... 71
3. The Glyptodon, ... 73
4. The Megatherium, ... 78
5. The Megalonyx, ... 87
6. The Mylodon, ... 88

V.—THE RUMINANTS, ... 90
1. The Cervus Megaceros, or Great-Antlered Stag, .. 91
2. The Sivatherium, ... 94
3. The Palaeoreas, ... 96
4. The Tragoceros, ... 98
5. The Palaeotragos, ... 99
6. The Helladotherium, ... 100
7. The Giraffe, ... 104

VI.—THE PACHYDERMATA, ... 107
The Hipparion, ... 108

VII.—The Pachydermata:—Ordinary Pachyderms, ... 116
1. The Erymanthian Boar, ... 116
2. The Anoplotherium and the Xiphodon, ... 118
3. The Palaeotherium and the Lophiodon, ... 123
4. The Leptodon, ... 127
5. The Anthracotherium, ... 127
6. The Paloplotherium, ... 127
7. The Acerotherium, ... 129
8. The Rhinoceros Pachygnatus, ... 130
9. The Rhinoceros Tichorhinus, or Tichorhine Two-Horned Rhinoceros, ... 131

VIII.—The Pachydermata:—The Proboscidea, ... 142
1. The Mastodon, ... 142
2. The Elephant, ... 155
3. The Dinotherium, ... 166

BOOK II.—THE BIRDS, ... 174
1. The Bird of Massachusetts, ... 179
2. British Fossil Birds, ... 183
3. The Gastornis Parisiensis, ... 184
4. The Dinornis and the Palapteryx, ... 186
5. The Epiornis, ... 191
6. The Archaeopteryx, ... 194

BOOK III.—REPTILES, ... 196
1. The Teleosaurus, ... 198
2. The Megalosaurus, ... 199
3. The Hylaeosaurus, ... 201
4. The Iguanodon, ... 202
5. The Mosasaurus, or Great Animal of Maestricht, .. 204
6. The Rhynchosaurus, ... 207
7. The Ichthyosaurus, ... 208
8. The Plesiosaurus, ... 215
9. The Pterodactyl, ... 220
10. The Ramphorynchus, ... 227
11. The Cheirotherium, or Labyrinthodon, ... 228
12. The Andrias, ... 232

BOOK IV.—FISHES, ... 237

BOOK V.—ARTICULATED ANIMALS, ... 248
The Trilobites, ... 250

BOOK VI.—THE MOLLUSCOIDA, ... 254
1. The Belemnites, ... 255
2. The Ammonites, ... 258

BOOK VII.—THE RADIATA, ... 262

BOOK VIII.—THE PROTOZOA, ... 270

BOOK IX.—PRE-HISTORIC MAN, ... 276

APPENDIX:—

1. On some Animals which have recently Disappeared, ... 311
2. British Fossil Mammalia and Birds, ... 314
3. Pre-Historic Man in Scandinavia, ... 321

TABLE OF FRENCH AND ENGLISH MEASUREMENTS, ... 329

INDEX, ... 331

LIFE IN THE PRIMEVAL WORLD.

Introduction.

I.

THIS book will treat of Fossil Animals, Fossil Vegetables, and Primitive Man.

We use the term "Fossil Animals," although it is by no means easy to explain it in a few words. Some thirty years ago, it is true, the task would have been a simple one.

For by "Fossil Animals" our paleontologists then understood all those which had flourished anterior to what was supposed to have been the last great revolution of the globe ; the cataclysm which divided the old world from the new, the world of gigantic saurians and huge edentata from the world of man.

Thirty years ago—how brief a period it seems, and yet how much in the interval has Science accomplished ! —Thirty years ago, the history of the earth, according to Hutton and Werner, Cuvier and Flourens, was a succession of "terrible events and revolutions,"* of "frightful catastrophes." † An able French naturalist, Alcide d'Orbigny," ‡ whose theory enumerated twenty-seven cataclysms destructive of animal and vegetable life, showed us, only fifteen years since, oceans upheaved from their beds by the last of these revolutions, and surging over the globe again and yet again.

But these ideas are no longer admitted, except by the last survivors of the epoch in which they were originated.

For it is now known, beyond all doubt, that no such event as a complete and instantaneous destruction of a fauna and flora, succeeded by a sudden appearance of a new fauna and flora, ever occurred. We must not look upon the work of creation as a series of phantasmagoria, changing in a moment at the bidding of the magician. Careful research has shown that between the close of a geological formation, and the extinction of the animals and vegetables belonging to it, as between the commencement of an era and the creation of new plants and new types of animal life, there is no necessary coincidence. The animals and plants of one period pass in the following period through the chimerical catastrophe which "sensational" geology intercalates between them. The paleontologist sees certain organized forms, hitherto unknown, make their appearance at any time in the course of a geological "age," and others, which have been long in existence, vanishing gradually from the scene, without the agency of any elemental disturbance.

---

* Cuvier, "Discours sur les Révolutions du Globe," p. 90.

† Flourens, "Éloge Historique de Georges Cuvier," p. 47.

‡ D'Orbigny, "Cours Élémentaire de Paléontologie," tome ii., p. 834.

For example: a "frightful cataclysm" intervened, according to the old school of geologists, between the Eocene formation (the last stage of the Tertiary period) and the Chalk (the first stage of the Secondary period). But we owe to Ehrenberg the discovery that the Chalk, which is wholly composed of polypes and shells, contains the remains of a considerable number of living species of molluscs. A similar fact has been demonstrated by the deep-sea soundings of Dr. Carpenter; and, indeed, species of foraminifera, long supposed to be extinct, are now known to be engaged in their silent and ceaseless labour beneath the waves of the existing seas. Thus, as Humboldt remarks, the Tertiary group superimposed immediately above the Chalk—a group ordinarily known as strata of the Eocene formation—do not, strictly speaking, merit that name, for "the day-dawn of the world in which we live stretches far back into the dim and misty ages of the young earth."

In truth, the specific identity which has been established between a great number of the molluscs of the Chalk and living molluscs, may be traced throughout the Tertiary "eons" between certain shells of the Tertiary strata and living shells. In 1858 Dr. Barthe presented to the *Académie des Sciences* a fine *pecten* from the Japanese Seas and the Gulf of Tartary, which Elie de Beaumont recognized as of the same species as the great *pectens* found in a fossil condition in the upper deposits of the Astesan (Piedmont), and other localities.

In the presence of such facts, what shall we say to the general cataclysm, the world-revolution, which the early geologists placed between the Tertiary and Quaternary periods? How could we bring this cataclysm in accordance with another important fact, that the cave-bear, the primitive elephant (*elephas primigenius*), the woolly rhinoceros, the Irish elk, and the aurochs (we might easily multiply our examples), were not only contemporaneous with the Pleiocene, or upper Tertiary strata, but also with the Post-Tertiary strata?

Elie de Beaumont himself—who by his genius and his labours did so much for the establishment of the sensational theory—Elie de Beaumont was influenced by the discovery of the pecten to which we have just referred, so far as to admit " the specific identity of certain shell-fish of the different Tertiary strata with shell-fish now living in different seas," and to declare "that this identity confirmed the opinion that the entire change frequently remarked in the fossil shell-fish in passing from one stratum to another immediately above it, might, in many cases, be due to the circumstance that the revolutions of the globe had sometimes changed the habitats instead of annihilating the species."

But this declaration considerably lessens the importance of the so-called revolutions of the globe. They could not have been as complete or as terrible as Cuvier and Hutton depicted them, if they permitted any types or forms of animal or vegetable life to escape destruction.

No: we are forced to the conclusion that these revolutions had neither the generality nor the intensity which the old school of geologists attributed to them.*

---

* Various theories of cataclysmal changes are examined by Sir Charles Lyell in his "Principles of Geology" (10th edition), i. 8–13, 32, 62, 102.

We must dismiss as without foundation the theory of D'Orbigny that the Creative Power seven-and-twenty times annihilated His glorious work, to reconstruct it seven-and-twenty times on a more perfect scale. We must not allow ourselves to be deceived into accepting Progress as so fantastic and capricious a development. What made these acts of destruction necessary? How long an interval elapsed between each? Did as many thousands of years pass over the Permian as over the Silurian formation? By what law was this alternation of creation and destruction governed? To such questions no reply is possible, because the whole theory is unsound. The Creative Power has incessantly eliminated and incessantly added, but always by a gradual and continuous labour. We may accept the idea of revolution undoubtedly, but only in a modified—or, rather, a purified—form, as expressing the radical change produced by the expansion of an element which, subordinating itself to the system wherein it is developed, changes the foundation of that system. Embryogeny is full of revolutions of this kind, and the history of life upon the earth has seen no others.

As for that general revolution, that universal deluge, the last of all according to chronological order, which established (it was said) the line of demarcation between the fossil and the living species, it was supposed to have occurred between the *Post-Tertiary* or *Diluvial* strata and the modern *Alluvium.*

But in the Post-Tertiary epoch, which preceded the present, certain great mammals lived, belonging, for the most part, to the Pliocene strata, and capable of division into three categories, according to their several conditions of existence:*—

1st. Some did not survive the Post-Tertiary epoch, but became extinct before it passed away. As, in Europe, the cave-bear and cave-hyena, the primitive elephant, the woolly rhinoceros; in America, the megatherium, the megalonyx, the mylodon, the glyptodon, the horse.†

2nd. Other formidable animals there were, contemporaries, like the former, of the Diluvium, which, having survived it, became contemporaries also of the modern Alluvium; yet have not come down to us. Such are the ox, the horse, the buffalo, the common stag, and the aurochs, whose remains are so generally found in what we call the "bone-caves" of Europe, as at Galeinreuth, Torquay, and other places.

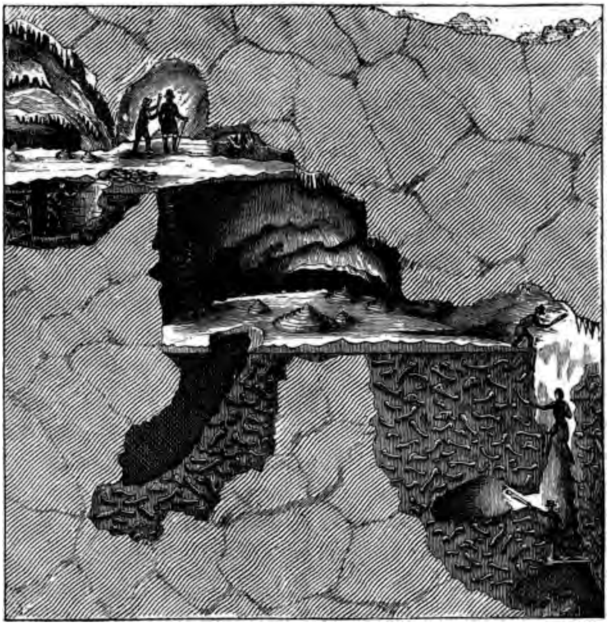
We have stated sufficient to show that the cataclysmal theory of Murchison and Sedgwick in England, and Cuvier in France, is without foundation; that no definite line of demarcation can be traced between the fossil species and the living species; and that, consequently, the definitions we were formerly content to accept must now be thrown aside.

Shall we then reserve the epithet "fossil" for those animals whose species are extinct? It is used in this sense by the unscientific, and in this sense, moreover, even Cuvier would seem to have understood it:—"Let

---

* V. Meunier, "Les Animaux d'Autrefois" (ed. 1869), pp. 15–17.

† The horse was unknown in the New World at the period of its discovery by Columbus, but Lund's researches have proved that it existed there in the Post-Tertiary period.



BONE-CAVE OF GALEINREUTH, BAVARIA.

any person ask himself," he says, "why we discover the remains of so many *unknown* animals, though we meet with none which we can ascribe to the species we *know*, and he will see why it is probable that they all belonged to the inhabitants of a world anterior to ours, to creatures destroyed by the successive revolutions of the globe, to creatures whose place has been filled by those we now see around us."

Alcide d'Orbigny, in language more precise and formal, says :—"All the terrestrial strata, from the most ancient down to the epochs nearest to our own, contain lost fossils only." And he adds:—"The fossils are not extinct simply in relation to the present condition of the earth; their families, their genera, and in every case their species, nearly all descend from one geological stage to another."

But Science, in the last few years, has strode rapidly onwards, and refuses to-day to consider "fossil animals" and "extinct animals" as identical. A number of species to which the epithet "fossil" may be applied with indisputable correctness, are still included among those that flourish now around us. We have just seen that such is the case with a great number of shells of the Cretaceous epoch, and with certain Tertiary shells. It is also the case with some of the mammals, as the aurochs and the reindeer. The opinion has been put forward that the "great cat of the caves" is identical with the lion which, after the invasion of Xerxes, disquieted in Macedonia the soldiers of the "king of kings," and that this lion still exists in certain secluded regions of Asia: if this opinion be well-founded, the *felis spelaea*, though still living, will not be the less a fossil. The proposed definition will therefore be too narrow, and would not contain all that it ought to contain.

Eliminating the idea of extinction, which is not essential, shall we designate by the term "fossil" all animals whose remains or vestiges are preserved in the strata of the earth?

But if such a definition were allowed, our graves and cemeteries would be brought within the domain of Paleontology; the bones of men and animals interred upon "red battle-fields" would become "fossil bones." The definition would, therefore, err by an opposite excess; it would embrace so much that it would designate nothing.

We might render it more exact, perhaps, by embodying in it both the idea of antiquity and the idea of an action produced without man's intervention. In such a case fossil animals would simply be—those whose remains have been *anciently* and *naturally* embedded in the strata of the earth.

But will the definition, thus qualified, answer our purpose? I think not. For, in the first place, what are we to understand by "antiquity?" At what epoch are we to regard the old order as giving place to the new? Did it end, for instance, at the commencement of the historic times?

What could be more arbitrary than this? For whatever the comparative accuracy and extent of our recollections as regards ourselves, they can have no real influence on the intrinsic value of the facts whose history is independent of our own. Can we qualify the cave-bear and the primitive elephant as fossils, and refuse this qualification to the *dodo*, only because the two former became extinct in an age of which history preserves no record, while the latter passed away at an epoch within our clear remembrance? In such a distinction there would be no value. And not only would it be perfectly arbitrary, but it would not permit us to establish any precise demarcation between animals which are fossil, and animals which are not. Science, in fact, is at this moment casting its magic light upon a Past which everlasting shadows would seem to have concealed from our wistful ken, and thus it restores to history the ages which it so grandly illuminates. Where the writers of a bygone day saw only a dim and uncertain beginning, we now see one of the stages of human development. How far will this resurrection of the Past extend? Where will our persevering researches meet with that impenetrable barrier which Science must perforce regard as its *ne plus ultra?* To such questions we can offer no reply, for we cannot pretend to limit the inquiries of the human intellect; and hence it is impossible to accept any demarcation, as at present understood, between the historic and prehistoric times.

It is true we might understand "antiquity" as terminating, in a paleontological sense, at the creation of man. And it was thus understood by Cuvier and his disciples. We should then say that fossil animals are those whose remains lie embedded in the strata deposited before the appearance on the scene of man, the "lord of creation."

But the geological date of this great event is unknown; and were it discovered, could only furnish us with a fanciful and ideal limit.

Let us, for instance, suppose that man, whom we know to have been alive in the Post-Tertiary epoch, does not date back beyond that epoch. The primitive elephant, the woolly rhinoceros, the cave-bear, and other mammals belonging originally to the Tertiary formation, had man as their contemporary in the Post-Tertiary. Of two things, therefore, we must allow one: either these animals will be fossils in the Tertiary strata, and will not be so in the Post-Tertiary, where they became extinct; or they will be fossils in the Post-Tertiary, and then the limit with which the creation of man might have furnished us is overthrown; and as the *mammoth* is fossil in the Diluvium, we do not see why the reindeer and the aurochs, whose bones are found in the great caverns, should not be so, as well as the *cervus megaceros* and the *urus*, which still existed in the days of Caesar, and the *dodo*, which did not pass away until the last century.

To sum up: the appearance of man, having in no wise affected the development of paleontological facts, cannot furnish us the line of demarcation we are in search of.

Thus much in reference to *antiquity*.

Will the idea expressed by the word "naturally" be of any greater service to us? We think not.

To separate here the action of man from that of nature, is again to insist upon arbitrary distinctions. Man has indisputably had a share in the destruction of the dronte; but did he play no part in the extinction of the cave-bear, the cave-tiger, and the cave-hyena, the primitive elephant, the woolly rhinoceros, the hippotamus major, the Irish elk, which have all disappeared since he inhabited Europe? Had he no share in the disappearance of the *dinornis* from New Zealand, and the *epiornis* from Madagascar? Moreover, when man destroys his own species, or species distinct from his own, does he do more than all carnivorous animals had done before him?

DINORNIS.

Whether a species be driven out from the country which it inhabited, or whether it be totally annihilated by the lion or the savage, is not the result exactly the same? I add, that to establish here any artificial categories, to put man upon one side and nature on the other, is to deprive ourselves of all means of gaining a clear insight into the great phenomenon of the extinction of species.

Thus, then, it is apparent, as I stated at the outset, that it is no easy task to fix the limit between *fossil* and *living* species. The transitions between both are as manifold as they are imperceptible. Of this let us make no complaint. If the phenomenon of the extinction of species had ceased, undoubtedly we should never have been able to understand it. It is because it is still in action, we may pretend to explain the events that transpired in the far-distant Past; in truth, to do so, we are required only to mark attentively what is nowadays taking place around us.

II.

The veriest tyro cannot be ignorant that the name of Cuvier is indissolubly associated with the history of Paleontology. He had his precursors, like Watt and Arkwright and Stephenson; no invention is ever the work, no science the successful labour, of one intellect. The all-important idea that certain forms of life were extinct had been already enunciated; the determination of the species whose vestiges lay buried in the bowels of the

CUVIER.

earth, had been attempted; but, not the less, the existence of paleontology as a distinct science is due to the research, the perseverance, and the insight (almost intuitive) of Cuvier. With the aid of a few petrified bones, he built up before men's wondering eyes the skeletons of animals which had perished tens of thousands of years before their time. He was enabled to work miracles by his admirable knowledge of comparative anatomy, and by his unerring sagacity he brought together the *disjecta membra* of the past into one harmonious and satisfactory whole.

But we will leave the biographer of Cuvier to explain the method which he adopted, and which led him to so many important discoveries:—

"The principle which has presided over the reconstruction of the lost species is that of the *correlation of forms;* a principle by whose means each part of an animal may be deduced through another part, and all parts through a single part.

"In a machine so complex, and yet so essentially one, as that which constitutes the animal body, it is evident that all its parts must necessarily be arranged with a view to their mutual relations, and so as to correspond, to adjust with one another, and, in fine, to form in their aggregation an unique being and system.

"Not one of these parts, therefore, can change its form but what every other part must also necessarily change. From the form of one we may, consequently, deduce the form of all the others.

"Let us take, for example, a *carnivorous animal:* it must possess, of necessity, *organs of sense*, *organs of* *movement*, *fingers*, *teeth*, a *stomach*, and *intestines*, arranged for the perception, overtaking, capture, rending to pieces, and digesting a prey; and all these conditions will be rigorously interdependent, for, if only one should fail, the rest would be without effect, without result; the animal could not subsist.

"Let us suppose an *herbivorous* animal, and the aggregate of conditions will then have changed. The *teeth*, the *fingers*, the *stomach*, the *intestines*, the *organs of movement*, the *organs of the senses*, all these parts will have assumed new forms; and these new forms will invariably be proportionate among themselves, and relative to one another.

"From the form of one alone of these parts, from the form (for instance) of the *teeth*, we may deduce—and deduce with certainty—the form of the *feet*, that of the *jaws*, that of the *stomach*, and that of the *intestines*.

"All these parts and organs, then, are deducible from one another; and such is the infallibility of this deduction, that we have frequently seen Cuvier recognize an animal by a single bone, or even facet of a bone; we have seen him determine unknown genera and species from a few broken fragments, and reconstruct a whole animal from a single one of its members, and from each, as it were, re-creating it at will; astonishing results, which we cannot recall without also recalling the admiration mingled with surprise they first inspired—an admiration and a surprise not yet enfeebled."

Surprise and admiration were, in fact, carried to a climax, and to such an excess that they prevented naturalists from appreciating at its exact value the rudimentary condition, even after all the labours of Cuvier, of our paleontological knowledge.

Geoffroy Saint-Hilaire, however, did not share in the general delusion, and long after Cuvier's immortal "Recherches sur les Ossements fossiles" were published, he candidly confessed that "the time had not arrived for a true and scientific system of Paleontology."

In this view he has been amply justified by the result of the labours of the last twenty years. For, to cite a few examples, the origins of a very great number, and even of the majority of fossils, have receded much further into the past than the epochs at first assigned to them; the mammals have descended to the bottom of the Jurassic formation; the saurians into the Old Red Sandstone. It is evident that, as Elie de Beaumont says, the outlines of Paleontology have been laid down on too narrow a scale.

In the second place, we have seen, and we still see, the *transitional animals* multiplying, which, far from belonging to new types, borrow their ambiguous characters from different genera in living nature.

Thirdly, the *meaning* of the facts of paleontology begins to be discernible. In his celebrated "Discours sur les Surfaces du Globe," Cuvier, seeking for a connecting link between the lost and present races, arrives at the conclusion, in opposition to Geoffroy Saint-Hilaire, that, in the facts known, there is no confirmation of the opinion that the fossils were the groundwork (so to speak) of the animals of the modern world.

But who would now espouse such a conclusion in the face of the manifold transitions which paleontology has revealed to us?

Finally, it has been found needful to introduce very considerable modifications in the method of determination created by and applied with so much genius by Cuvier. Of this we shall have numerous proofs in the following pages, as we pass in review the most remarkable forms of Life in the Primeval World.

BOOK I.—THE MAMMALS.

CHAPTER I.

QUADRUMANA: THE APES.

I.

TOWARDS the close and nearly at the last page of his celebrated "Discours sur les Révolutions du Globe," Cuvier, after enumerating all the genera of fossil animals which he had discovered, remarks:—

"It is astonishing that among all these mammals, the majority of whom have their congeners nowadays in hot countries, not a single quadrumane has been found; not a single bone or tooth of an ape, and not even the bones or teeth of apes of extinct species." *

Cuvier wrote this in 1830.

Four years later, Flourens, perpetual secretary of the *Académie des Sciences*, in his Eulogium upon Cuvier, delivered before that learned body, said, in his turn:—

"The fact is specially noteworthy that, among all these animals, there is not a single quadrumane, not one ape."*

---

* Cuvier, "Discours sur les Révolutions du Globe" (Paris, 1848), p. 221.

Recently, however, a "fossil ape" has at last been found; and found—a circumstance not less remarkable than the discovery itself—not in the most modern strata of the globe, but in the mid-Tertiary formation, or *Miocene.*

The extent of our knowledge on this important point was summed up in the following words, about eighteen years ago, of one of the most eminent of foreign paleontologists:†—

The existence of a fossil ape was ascertained for the first time in 1836. Messrs. Baker and Durand, in the *Journal of the Asiatic Society of Bengal*, described an upper half jaw of an ape as large as the ourang-outang, akin in the structure of its teeth to the semnopitheci. This jaw was found in the Miocene strata of the Himalayas, near the Sutlej.

Soon afterwards, in 1837, Messrs. Falconer and Cautley met with (in India) some other fragments of apes belonging to species different from that described by Baker and Durand; one of the same size as the living species named *eadette*, the other larger.

Early in this year 1837, M. Lartet had discovered, not in a country nowadays inhabited by apes, but, far more curious to say, on the very soil of France, a jaw of an ape allied to the gibbons. This fossil is known as the *Pliopithecus antiquus* (Gervais).

---

* Flourens, "Analyse raisonnée des travaux de Georges Cuvier, précédée de son Eloge historique" (ed. 1841), p. 17.

† Gaudry, "Animaux fossiles et Géologie de l'Attique" (ed. 1862), p. 19.

By a curious coincidence, Mr. Lund, in the very same year, likewise announced the discovery of remains of fossil apes in the New World. He indicated two species found in Brazil—one of the genus *Callithrix;* the other of an unknown genus, which he named *Protopithecus*, and which was not less than four feet in stature. These species belong to the "division of American apes."

In 1839, Sir Charles Lyell found in the London clay of Suffolk the debris of an ape which Professor Owen at first supposed to be a macacus (*Macacus eocoenus*), but he has latterly substituted the name of *Eopithecus.* In his "History of Fossil Mammals and Birds," the same naturalist has figured a tooth of *Macacus pliocoenus*, from the brick-earths of Essex.

M. Gervais has discovered at Montpellier, in the Pliocene fresh-water marl, a fragment of the fore-arm and some teeth, which he has described under the name of *Semnopithecus monspessulanus.*

Lastly, M. Lartet has brought before the scientific world a fragment of the face, a lower jaw, and a humerus of the *Dryopithecus Fontani*, a great ape belonging to the group of the higher Simiadae. These pieces were found in the Miocene strata of Saint Gaudens, in the Upper Garonne, by M. Fontan.

As early as 1852, therefore, three species of fossil apes were known, and had been found in the various stages of the Tertiary formations:—

The Macacus pliocoenus, in the upper strata;

The Dryopithecus Fontani, in the middle; and

The Eopithecus (first named Macacus eocoenus), in the lowest strata.*

II.

Nay more: among these fossil apes were two—the *pliopithecus antiquus* and the *dryopithecus*, both discovered by M. Lartet—which belonged to the group of the higher apes (troglodyte, chimpanzee, ourang, and gibbon), or the *Anthropomorphic*, as we name them.

Of these anthropomorphic fossil apes, one, the pliopithecus, was contemporary with the upper Tertiary formation (or the Pliocene); the other, the dryopithecus, with the middle Tertiaries (the Miocene).

The former was of small size.

The latter, on the contrary, exceeded in dimensions the adult chimpanzee.

The remains of the latter were discovered in a fresh-water deposit, a bed of marly clay which was being worked, at the foot of the table-land occupied by the town of Saint Gaudens, and at the entrance of the plain of Valentine, which extends from thence to the outermost buttresses of the Pyrenees. These remains consisted of two varieties of a lower jaw truncated in their ascending branches, in a fragment of the anterior face of this jaw in which the incisor teeth were embedded, and in a humerus epiphysed at its two extremities.

This ape differs from the chimpanzee, ourang-outang, gorilla, gibbon, and pliopithecus in some dental details, and especially in the shortening of the face. The incisors being much reduced, and the molars largely developed, show that it fed almost wholly upon herbs and vegetables. The little we know of its limbs indicates more agility than strength. Lartet thinks it lived in the trees, as the gibbons do nowadays; hence its generic name *dryopithecus*, from δρῦς, an *oak*, and πίθηκος, an *ape.*

---

* Professor Owen now thinks he can recognize in the latter one of the Suidae. But, to compensate, Rütimeyer has found in the Eocene three teeth belonging to a quadrumane, the *Coenopithecus lemuroides*.

III.

To the foregoing list of fossil apes M. Gaudry has recently added a new item, and one especially remarkable, formed by an ape discovered in the upper Tertiary formation (*Pliocene*) of Pikermi, in Greece. It has received the name of *Mesopithecus Pentelici.*

To appreciate fully the interest of this discovery, we must remember the words of Cuvier in his great *Discours*:—

"The smallest bony facet," he writes, "the least apophysis, have a definite character in relation to the class, the order, the genus, and the species to which they belong; so that whenever one has but an extremity of bone well-preserved, one may, with application, and by a skilful use of analogy and comparison, determine every characteristic as certainly as if one possessed the entire animal."

We shall learn from the ape of Pikermi whether we may place absolute confidence in this principle.

The existence of the mesopithecus was known anterior to the researches of M. Gaudry, but it was he who determined the true characteristics of this fossil.

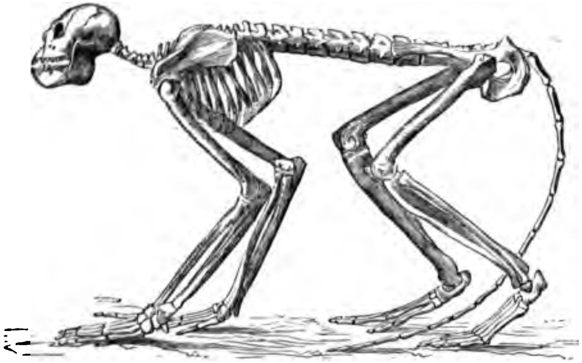
Mesopithecus (from μέσος, *middle*, and πίθηκος, *ape*) signifies "intermediary ape;" and though Wagner, who so entitled it in 1854, was mistaken, as he has since acknowledged, in the relations of the ape thus denominated to living apes, the name "mesopithecus" remains perfectly appropriate to our quadrumane.

Wagner possessing only some pieces, and these probably mutilated, of the skull, thought he recognized in them a mixture of the distinctive characters of the semnopithecus with those of the gibbon, which is, as the reader knows, an anthropomorph. The truth is, that the animal of the Pentelicus has no kinship with the latter. But though possessing other affinities than he was at first accredited with, he is not the less an *intermediate* ape, as we are about to show.

The first normal skulls were discovered by M. Gaudry in 1836; they retained the teeth. In accordance with M. Lartet's view, he referred the Attic ape to the semnopithecic genus. In the following year, M. Wagner, modifying his first decision to adopt the views of the two French paleontologists, proposed to convert the genus in question into a sub-genus of *Semnopithecus*. And, lastly, in 1860, M. Beyrich, relying on the examination of a complete skull, identified our fossil with the semnopithecus, and designated it *Semnopithecus Pentelici*. Thus, so far as its skull is concerned, we find that the ape of Attica is a semnopithecus.

Thus things remained when, in 1860, M. Gaudry resumed the researches that had been interrupted for four years. Rarely has a paleontologist been fortunate enough to carry out his investigations on so grand a scale. And such was their productiveness that, besides twenty skulls and isolated jaws, M. Gaudry found himself in possession of a sufficient number of bony fragments, belonging to all the regions of the body, to be able to reconstruct almost an entire skeleton of the mesopithecus.

He was able, therefore, to take into consideration the proportions of the limbs;—elements of determination whose importance will be understood if the reader reflect on the variations experienced by these appendages in the same family among apes now existing.



SKELETON OF THE MESOPITHECUS.

Regarded from this point of view, the ape of Pikermi separated itself more and more widely from the semnopithecus. While, in fact, the posterior limbs of the latter are much longer than its fore-limbs, the inequality is much less conspicuous between those of the mesopithecus, which, in this respect, is exactly in the condition of the macacus.

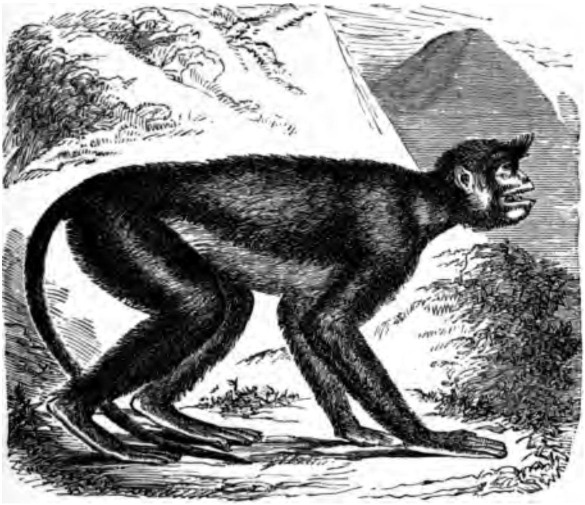
A semnopithecus by the head, it is then a macacus by the limbs, and even by the delicate gradations which, in the very parts through which it is the most strictly connected with one or other of these two genera, still recall the genus whence it recedes: thus, its head is somewhat more massive and its teeth are somewhat stronger than those of the semnopithecus, so that it slightly approaches the macacus; and its limbs are somewhat less unwieldy than those of the macacus, in which it slightly approaches the semnopithecus.

For the mesopithecus, then, we have a fossil which borrows its characters from two distinct genera in living nature, and exactly intercalates between them; and its history proves to us that when we would discover the exact place a vertebrate animal ought to occupy in the zoological series, far from an extremity of a bone always proving sufficient, the whole head is sometimes not enough, and the paleontologist must also know the limbs.

Among the mesopitheci considerable differences have been remarked in the dimensions of the skull and other parts of the skeleton, and in the length of the canine teeth. Hence Wagner came to the conclusion that there were two species of mesopitheci; but M. Gaudry has proved that the more robust bones belonged to the male. The same differences are observable in living apes between the two sexes, as Audebert tells us in his "Histoire des Singes et des Makis": "The individuals of each species of ape differ surprisingly from one another. They differ in magnitude, thickness, colour; so that several species have been created out of these individual differences."

We shall now endeavour, with the great French paleontologist as our guide, to describe the appearance and habits of the Primitive Ape.

We conclude that an animal whose teeth and bones, and, consequently, whose muscles, tendons, and ligaments, resemble those of the apes now existing, will also resemble them, more or less, in external aspect.



MESOPITHECUS, RESTORED.

The mesopithecus, therefore, we take to have been about nineteen inches long, from the head down to the extremity of the pelvis. The bones of its hind-legs were much longer than those of its fore-limbs; but as the omoplate invariably increases the total length of the latter, its fore-shoulder would be very nearly the same height as its hind. When crawling along the sward it was probably two feet (thirty centimètres) high. Its dimensions, consequently, were nearly those of a young macacus, and it resembled that animal in the proportion of its limbs. But its head was different, approaching in form that of the semnopitheci; its face somewhat projected; it had not, as the macacus has, two great upper incisors. In comparison with its height, its tail was of enormous length; at all events, it must have been longer than its body, and therefore upwards of twenty inches.

Apes, such as the semnopitheci and monkeys, whose thighs are long, leap with great agility from branch to branch; the gibbons, whose fore-arms are extraordinarily large, easily embrace the trunk or stem; both are climbers by nature, and live in the trees. But the macaci, the baboons, and, in general, all apes with shorter and more evenly proportioned members, do not possess the same facilities for climbing. As a compensation—for Nature treats none of her children unfairly—they tread the earth much more firmly and swiftly than those of their congeners whose fore and hind limbs exhibit such a disproportion; hence they make their haunts among the hoary rocks and lichened crags rather than among the leafy boughs. We conclude, therefore, that the mesopithecus, from the resemblance of its limbs to those of the macacus, stalked along the marble foundations of future Greece more frequently than it climbed from tree to tree.

From the number of individuals which the paleontologist has disinterred, we are justified, perhaps, in asserting that it was a gregarious animal, like the modern ape. Travellers declare that you never meet among the individuals of one species any apes belonging to another.

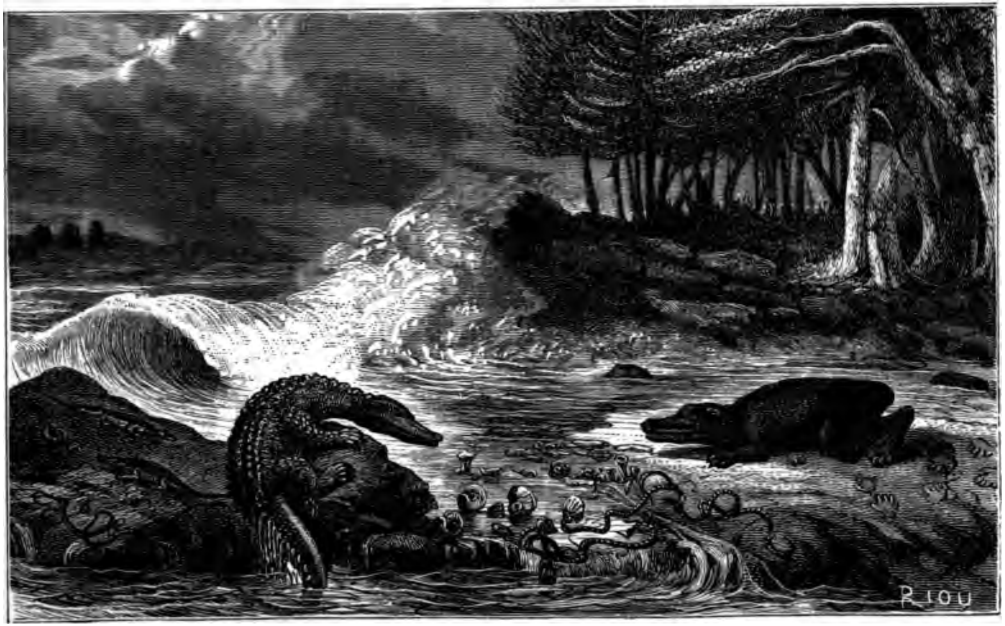
And since at Pikermi only a single species of ape has been discovered, it was, I believe, the custom of the mesopitheci, as of modern monkeys, to shun the acquaintance of strangers: each troop was composed of individuals all belonging to the same species.

The teeth of those apes which approach nearest in organization to man, such as the chimpanzee and the gibbon, are arranged upon the omnivorous type. Those of the mesopithecus are very different, and, like the teeth of the semnopitheci, seem to have been designed for kneading and mashing the fibrous and herbaceous portions of vegetables. The teeth of the lower jaw are found much worn on the outer edge, and those of the upper jaw on the inner edge—a proof that the mesopithecus masticated its food as we do, by causing the lower jaw to slip inside of the upper.

The mesopithecus had a thumb on its fore-limb, and therefore could seize objects adroitly with its hand; yet, that thumb being slenderer than the middle fingers, it did not possess so much prehensile force as the apes nearest akin to man, with whom the thumb is the thickest finger.

The fingers of the hind-limb of the mesopithecus were longer than those of the fore. With these long fingers, inconvenient as they were in walking, it was able, like our modern apes, to remain confined in narrow spaces.

It may be added that the teeth of the fossil apes found at Pikermi were not very black, consequently they did not die of old age; and their destruction would seem to have been caused by some convulsion of physical nature.



" WALLOWED IN THE SEETHING SLIME OF TROPICAL ESTUARIES."

CHAPTER II.

THE CARNIVORA.

> Those physical monuments of His power that God has put before our eyes, giving us at the same time faculties whereby we may interpret them.—PROFESSOR SEDGWICK.

IT may be permitted us to wonder whether our readers have ever attempted to obtain a definite idea of the aspect which this world must have presented in the earlier ages of its history. Have they ever sought to throw their imagination back into those remote days when Man, if Man existed, was a rude and untutored inhabitant of the wilds, earning a precarious existence by the chase? Or to that period, perhaps still more distant, when huge rivers of ice ground their way over the young earth's plains, filled its valleys, and toiled around its hills, leaving the marks of this tremendous progress to be traced by the curious eyes of modern geologists? Or to those days when mighty beasts, huge of form and terrible to the sight, stalked through the intertangled woods, or wallowed in the seething slime of tropical estuaries? When minute coralline creatures lived, and wrought, and died, as if for the sole purpose of building up those masses of limestone from which the hand of labour now quarries the materials of our mansions, our palaces, and our temples? When the mastodon, and the plesiosaurus, and the iguanodon flourished,—types of living genera, but constructed on a larger and, may we not say, a ruder scale?

Did the reader ever seek, we ask, to place before his mind's eye a correct picture of this ancient earth in its early stages of development, and to contrast it with the world now smiling and blooming around him—an earth so beautiful that it instinctively colours all our conceptions of heaven?

The poet and the romancist* have sought to imagine the final scene of the world's great drama, when among the "skeletons of nations" one man alone survives, serene and unshaken amid the ruins of a world. "I had a vision in my sleep," exclaims the poet Campbell,—

"That gave my spirit strength to sweep
Adown the gulf of Time;
I saw the last of human mould
That shall Creation's death behold,
As Adam saw its prime."

Such a conception is altogether fanciful and untrue, however it may impose upon the imagination. A fitter theme for the poet, and one of far more grandeur, would be the first age of the world, when the masses of land that now form our continents were but as islands in a waste of waters,—when dense luxuriant forests occupied the site of future estuaries,—when glens and meadows, now fair and fertile, lay crushed beneath the superincumbent ice. Let him place his imaginary hero on this desolate stage, and bid him watch the mountain-peak gradually rising above the heaving waves; the billows sinking as the land emerges, and slowly confining themselves within their definite channels; the desert giving place to the rich pasture and leafy grove; and each succeeding transformation revealing new beauties of adaptation and arrangement to the observer's view. It seems to me that the highest poetry might be rightly employed on a task of so much loftiness.

---

* Notably Mrs. Shelley, in her weird romance of "The Last Man."

Some such study, at all events, we may propose to our more prosaic capacities, and derive from it a treasury of sublime thoughts and gorgeous fancies.

But the reader will ask, How can such a study be conducted? Where are its materials? The account which the Bible supplies of the work of creation is comprehensive, but enters into no details. We are told that the waters beneath the firmament were divided from those above; that the sun was set in its appointed course as the orb of day, the moon as the orb of night,—

> "Serene in virgin modesty she shines;"

that the land was clothed with luxurious vegetation,—

> "Bathed in soft airs, and fed with dew;"

and animal life called into existence by the Almighty's word. But this is all, says the reader, we can gather from "Holy Writ." What species of vegetation, what varieties of animal life were first created, it does not inform us; and there is no other revelation to enlighten us upon these mysteries. Here, however, the reader is mistaken. Such a revelation *does* exist, and a revelation not less truthful or valuable than a written one; a revelation which equally proceeds from the Divine hand. It is the revelation of the Earth itself,—the Testimony of the Rocks,—a revelation and a testimony which lie conspicuously before us, and by none can be misunderstood.

The study of this revelation has led to the formation of two sciences—Geology and Paleontology.* The former deals with the earth's crust, and its strata or formations; Paleontology, with those relics of a past world which the said strata embody. Thus it is that every pebble, every shell, every layer of sand or lime may be made useful in developing the successive stages of creation, and that, in a sense somewhat different from the Shakspearian, we find "sermons in stones." Aided by these memorials, the geologist describes the gradual progress of Earth from the beginning, explains its present appearances, and tells us how the valley was hollowed, the mountain elevated, the coral island built up. He shows that it has gone through certain great cycles or periods, and that to each period has belonged its peculiar forms of animal and vegetable life. He demonstrates the various chemical, mechanical, and physical operations which have at different epochs affected the surface of our planet. He proves, as Professor Sedgwick says, that there were former conditions of the earth, separated from each other by vast intervals of time, during which man, and the other creatures of his own date, had not been called into being. Here the paleontologist steps in. From the fossil remains of extinct races—from the bones entombed in all-concealing earth—he creates anew, as it were, the animals which belonged to this "hoar antiquity." To each condition of the globe he appropriates its special types of animal life. He shows that from the earliest moment, when the sun's vivifying light fell upon the new-born sphere, life has been enjoyed; and that with life has come its constant necessity, death. He teaches that not only the individual, but the species perishes; that there have been unceasing developments of creative power; and that "in respect to no one class of animals has the operation of creative force been limited to one geological epoch."

---

* Geology—γη, *earth;* and λογός, a *discourse:* Paleontology—παλαιός, *ancient;* ὄντα, *beings;* and λογός.

In the following pages I do not pretend to give even the outlines of these two grand sciences. But I may, perhaps, stimulate my readers to their study by showing how much of strange and romantic interest they possess; by glancing at a few of the curious facts they have established; and by describing, in plain and simple language, some of the types of Life in the Primeval World which they have revealed.

It is necessary I should commence with a few words upon the Earth's crust, that the reader may understand the scientific terms I shall occasionally be forced to use.

The crust of the globe may be described as floating on "an internal nucleus of molten elements"—those elements which, at times, break forth through volcanic openings, like the billows of a subterranean sea.

The crust, or outer covering, consists of various materials, arranged in layers or *strata*, mostly horizontal, of different degrees of thickness. They form two principal sets, or groups, of rocks; namely, the massive and *unstratified*, like lava, which are evidently the product of *igneous* eruption; the *stratified*, which occur in layers, and have resulted from *aqueous* or sedimentary operations. These again are subdivided, according to their age and characteristics, into *epochs*, *periods*, and *systems*. The oldest belong to the *Palaeozoic cycle*, which includes the *Hypozoic* (Under Life) and *Palaeozoic* (Ancient Life) *periods;* the more modern to the *Neozoic epoch*, comprising the *Mesozoic* (Middle Life) and *Kainozoic* (Recent Life) *periods.* The *systems* are distributed in the following order, beginning with the latest in point of time:—

Rock Systems.	Life Periods.	Cycles.
Post-Tertiary, or Quaternary	Kainozoic	Neozoic.
Tertiary	"	"
Cretaceous	Mesozoic, or Secondary..	"
Oolitic	" "	"
Triassic (Upper New Red Sandstone)	" "	"
Permian (Lower New Red Sandstone)	Palaeozoic..............	Palaeozoic.
Carboniferous	"	"
Devonian (Old Red Sandstone) ..	"	"
Silurian	"	"
Cambrian	"	"
Metamorphic, or Primitive	Hypozoic..............	"

[These terms are explained in the NOTE to this section.]

Such are the various formations into which geologists, upon good and sufficient evidence, have arranged the stratified crust of the earth,—"the great chapters, as it were, of world-history, whose strata, like the leaves of a mighty volume, are indelibly stamped with the forms and characters of extinct vitality." To each formation belongs its peculiar species of organic beings, as may be seen in the following table :—

Systems.	Animals.	Thickness cf Strata.
Post-Tertiary: Diluvium and Alluvium	Man	2000 feet.
Tertiary: Pliocene	Mastodon, &c.	
Miocene	Quadrumana (apes, &c.)	
Eocene	Birds and Mammalia.	
Cretaceous	Fish (soft-scaled)	1300
Jurassic: Oolitic—Upper, Middle, and Lower	Marsupialia	900
Lias	Fish (homocercal)	2000
Triassic : New Red Sandstone Trias	Traces of Mammalia and footprints of Birds.	
Permian	Reptilia.	
Carboniferous	Batrachia (frogs)	4000
Devonian	Insects	10,000
Silurian	Fish (heterocercal)	2500
Lower Silurian	Mollusca (Cephalopoda) (Gasteropoda) (Brachiopoda)	20,000
Cambrian	Invertebrata (Crustacea). Annelids, &c. Zoophytes, &c.	

In our survey of the fossil remains embedded in the earth's crust, we shall commence with the lowest or most simple forms, and glance both at the Animal and Vegetable Kingdoms.

But first we must assist the reader to distinguish between an *animal* and a *plant*, availing ourselves, for this purpose, of Professor Owen's definitions.

Organisms, or living things, are those which possess such an internal cellular or cellulo-vascular structure as can receive fluid matter *from without*, alter its nature, and employ it for nutriment. Such fluid matter is called *nutritive*, and the actions which make it so are called *assimilation* and *intussusception*. These actions are designated *vital*, because, as long as they last, the "organism" is said "to live."

When the organism can move, has a mouth, inhales oxygen and exhales carbonic acid, it is called AN ANIMAL.

When it is rooted, has neither mouth nor stomach, exhales carbonic acid, and has cellulose tissues, it is called A PLANT.

When it is of minute size, retains the forms of "nucleated" or aggregated cells, and though without stomach, mouth, or root, possesses the common organic characters of both plants and animals, it belongs to the curious family known as PROTOZOA ("first-life" or "life-rudiments"), such as sponges, diatoms, rhizopods, and the infusorial animalcules. These latter, as their name indicates, were the earliest organisms created on the surface of our planet.

NOTE.—The different periods or systems derive their names from the following circumstances:—

Metamorphic: because the rocks have undergone considerable change and modification through the agency of fire. Thus granite, porphyry, and basalt have been forced in a melted state through gneiss and mica-schist.

Cambrian: so named by Professor Sedgwick, from Cambria, the ancient name of Wales, where this formation abounds.

Silurian: so named by Sir Roderick Murchison from the Silures, an ancient tribe inhabiting Radnor, Brecon, Hereford, and Monmouth, where the sandstones and limestones of the period are largely developed.

Devonian: from Devon, where the Old Red Sandstone lends so picturesque a character to the scenery. It also abounds in Scotland, in parts of Caithness and Sutherlandshire, and along the line of the Grampians.

Carboniferous: i.e., coal-yielding. The strata so called chiefly consist of sandstone, shale, ironstone, clay, coal, millstone grit, and mountain limestone.

Permian: the lower beds of the New (or more recent) Red Sandstone, so named by Sir Roderick Murchison, from the ancient kingdom of Permia, in Russia.

Oolitic: consisting of beds of clay, sandstones, limestones, coral reef, Bath stone, yellow freestone, fuller's-earth, shale, marls, &c. So called from *ωον*, an *egg*, because it seems to be composed of an aggregate of minute egg-like particles.

Cretaceous: from *creta*, Latin, chalk.

Tertiary: from *tertium*, Latin, third; because it includes the deposits made in the *third* or Kainozoic epoch of creation. The prevailing materials are sands, clays, and chalks, and generally they occupy considerable depressions in the chalk. Paris, London, and Vienna are situated upon Tertiary strata.

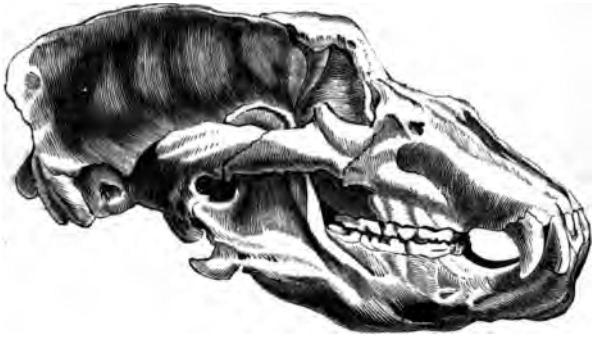
I. THE BEARS.

The genus of *bears* is found very widely distributed in a fossil state. Their bones abound in France, Belgium, Germany, and England.

For centuries they seem to have been dug out of the earth in enormous quantities, without any person forming a suspicion of what kind of animal had originally owned them. They were valued on account of their teeth, to which ignorance and superstition did not fail to attribute the most marvellous virtues; and in ancient pharmacy they figured under the name of *fossil licorn.* In an interesting French work, entitled, "Éphémérides des Curieux de la Nature," occurs a tolerably good representation of a skull of the fossil bear; but the author of the accompanying letterpress is very anxious to demonstrate that the head represented belonged to a winged dragon, and has even the audacity to assert that the said dragon still exists in Transylvania.

There are several species of fossil bears.

The most celebrated, and, certainly, one of the most remarkable, is the powerful cave-bear (*Ursus spelaeus*), which the French also designate the *ours à front bombé.*



SKULL OF THE CAVE-BEAR.

Its skull is distinguished from the present species by its great size, the constant absence of the small gap-teeth, the convex forehead (*front bombé*), and the prominent frontal projections forming a ridge upon the forehead. Though Blainville considers all the remains of bears found in caves to be of the same species as, and, in fact, identical with, both the brown bear of Europe and the gray and black bears of Europe and North America, all other naturalists * are agreed in considering the distinction between the cave-bear and existing species to be greater than that which obtains between different existing species; so that we must either assume, says Vogt,* that all living bears belong to the same species, or that the cave-bear represents an extinct type.

---

* See M. de Nordmann's "Paléontologie de la Russie Méridionale."

The cave-bear was about one-fourth larger than the largest of living bears, but he was of considerably shorter stature. Some of the skeletons which have been discovered measure about 6½ feet in height, and 9½ feet in length.

According to Vogt, notwithstanding the differences between the cave-bear and the brown bear, the former was the original stock of the latter. He regards as intermediate forms † the *Ursus arctoides*, which, though of the same size as the cave-bear, had neither such thick bones nor its frontal protuberances; the *Ursus leodiensis*, smaller than the cave-bear, and also without frontal eminences; and the *Ursus priscus*, still smaller in size, but larger than the present brown bear, though resembling it in profile. He also refers to the brown bears found in the caverns of Switzerland as having possessed enormous skulls, approaching that of the cave-bear.

All these transitional forms are very rare. While of cave-bears and brown bears we collect the skulls by hundreds, of the others our specimens are few and far between.

The large, ferocious, and formidable cave-bear corresponds, says Vogt, with the conditions which surrounded him, just as the living brown bear corresponds with existing conditions. It may be conjectured that the transition from the cave period to the present occupied but a very short time; and that, consequently, the transitional forms, indicating the oscillations between the two fixed types, are very rare, compared with those extreme forms which we recognize as independent species.

---

* Vogt, "Lectures on Man," p. 242.

† Ibid, p. 453.

That the cave-bear was contemporaneous with primeval man, is proved from the concurrence of the bones of the former with the remains of human industry.

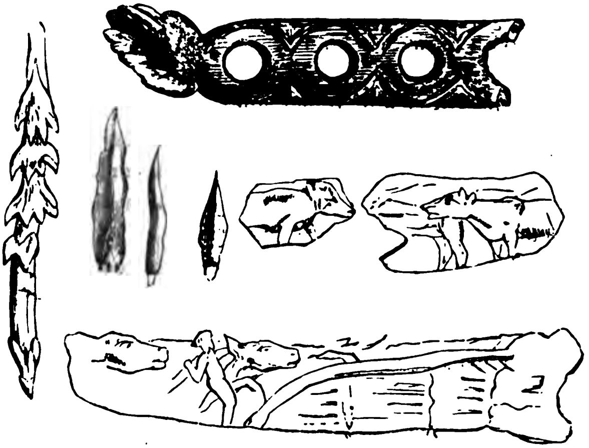
Thus, in the cave of Lherm, in the department of Ariège, the floor is covered with a deposit of fossiliferous mud, in which have been found, along with the teeth, shoulder-blade, arm and foot bones of man, a number of bones of the cave-bear, the old brown bear, some few remains of the cave-hyena, the cave-lion, the dog, the wolf, and some species of deer. Of the cave-bear there were seven skulls, fifty half lower jaws, above three hundred teeth, all the bones of the skeleton, and even some of embryos. The human teeth were discovered in a thin layer of mud intermixed with hyena and bear teeth, under a thick stalagmite incrustation, which was so crystalline as to split, when struck with a hammer, into large crystalline planes. There was abundant evidence that this crust had never been disturbed. Not only human remains were exhumed, but significant relics of human industry: a triangular flint knife, a round bone of the cave-bear fashioned into a rude cutting instrument, three lower jaws which had been perforated for the purpose of hanging them up, and the trochings of a deer carved and pointed. The most singular weapons, however, consisted of twenty half jaws of the cave-bear, which had been so manipulated as to convert the body of the jaw into a convenient handle, while the projecting canine tooth formed a kind of hook, useful, perhaps, as a weapon, or as a hoe for digging up the earth.

From the absence of rolled stones, and the condition of the mud, which contains many excrements of hyenas, as well as traces of coals and fire, the explorers of this cave, Messrs. Rames, Garrigou, and Filhol, have come to the conclusion that it was inhabited by beasts and human beings alternately; but that, at all events, man lived contemporaneously with the cave beasts, since he wrought their bones into tools and weapons.

Similar evidence has been found in the bone-cave of Aurignac, in the department of the Haute Garonne, explored by M. Lartet in 1860. The explorer furnishes a list of the animals whose remains could be identified: eighteen to twenty foxes, five to six cave-bears and cave-hyenas, three wolves, one to two badgers, the wild cat, the polecat, the cave-lion, the common bear. Numerous human bones, flint implements of excellent workmanship, the sandstone slabs of a rude hearth, with a layer of ashes and charcoal, bore significant testimony to the former presence of man.

II. THE METARCTOS.

The *Metarctos* (from *μετά*, *after*, or *in succession to*, and *ἄρκτος*, *a bear*) was so named by M. A. Gaudry, because it seems to have occupied an intermediate position between the bear and the dog; resembling the latter in the carnivorous and the last premolar of its lower jaw; and the bear, especially the white bear, in various dental characters—among others, by its elongated tuberculose.



TOOLS AND WEAPONS FOUND IN BONE-CAVES IN FRANCE.

In the general form of its jaw it approximates more closely to the raccoon than the bear.

The metarctos is identical with the animal which Roth and Wagner, in 1832, named *Gulo primigenius*, or the primeval glutton, because the jaw which they had before them chanced to be deficient in what is really one of the animal's most characteristic teeth, the tubercular. Roth was therefore of opinion that the jaw had belonged to a glutton, while it belonged, in truth, to an animal conspicuously distinct from living animals; an animal which, as we have said, formed a link between the bear and the dog.

Judging from the proportions of these parts of the animal which have been discovered, the metarctos was about the size of a small panther; but the remains we possess are too few to assist us in a correct determination of its habits. We may suppose, however, that it did not principally feed upon living prey, like cats and gluttons, but was more omnivorous in its diet. If the shortness of its jaws seems to prove that its masticating power was great, the smooth surface of the *talon* of its canine teeth, and especially its under tubercule, longer proportionally than in any carnivora, indicate that its teeth had other uses than cutting up flesh.

The *amphicyon*, the *hemicyon*, the *pseudocyon*, and the *arctocyon* are fossils more or less akin to the raccoon (*procyon*, *Ursidae* family) and the dog. Gaudry asserts that when these animals, as well as the metarctos, are better known, they will undoubtedly compose a group, comprehending in part the subursine genus of Blainville, and connecting the family of the Ursidae with that of the Canidae.

III. THE ICTITHERION.

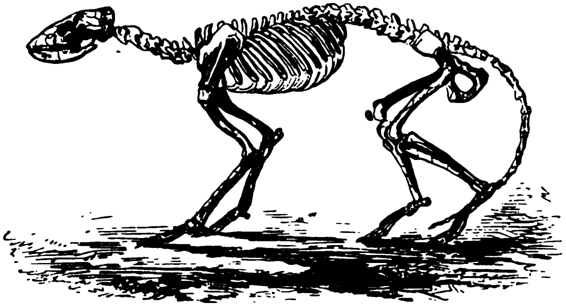
The *Ictitherion* (from ἰκτίς, *marten*, and θηρίον, *animal*) is a carnivorous animal of the Viverridae family,* but a viverrid with many of the characteristics of the hyena. So far as regards its dentition, and numerous osteological details, it is a viverrid; in the form of its upper canine teeth, its zygomatic arches, the orifices in its cranium, and its auditory drums, it belongs to the Hyaenidae.

Three species of the ictitherion were discovered by Gaudry at Pikermi.

The first, the *Ictitherium robustum*, would seem to have been the commonest carnivora in ancient Greece. It is probable that its mode of life was analogous to that of the living hyenas, and, perhaps, like the brown hyena, it prowled about the sea-shore in search of the carcases of animals flung there by the waves.

---

* A family of Carnivora, to which belong the civet, genet, and ichneumon.



SKELETON OF THE ICTITHERIUM ROBUSTUM.

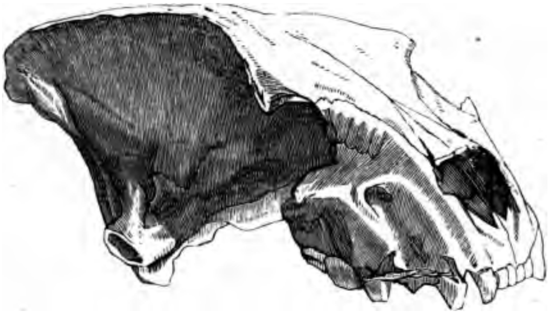
The second species, the *Ictitherium hipparionum*, was larger than the preceding, and surpassed in size all the members of the Viverrid family. It was less powerful, however, than the living species of *Hyaenidae.* As its teeth differ but little from those of the *ictitherium robustum*, it probably fed on the same kind of food.

The last species, the *Ictitherium D'Orbignyi*, is easily distinguished from the former by its small dimensions; it was one-third smaller than the first, and one-half less than the second. Its food does not seem to have been identical with that of its congeners; from its slenderer and sharper teeth we should conjecture that it preyed upon insects, and the conjecture seems confirmed by the animal's diminutiveness. Just as to-day the zibeth of India and the civet of Africa are attended by the genets as acolytes, so the great ictitheria of Greece were of old accompanied by the *Ictitherium D'Orbignyi.*

IV. THE HYENAS.

At the present day the hyena is unknown in Europe, except in menageries and museums; but in a fossil state he is represented in most European countries by an immense number of individuals.

The cave-hyena (*Hyaena spelaea*) is found associated with the cave-bear in bone-caverns, and has also been discovered by M. Declesse in company with the aurochs and the woolly-haired rhinoceros in the lower Diluvian strata. It may not be improbable, as Lartet suggests, that the lions of Thessaly which, as Herodotus tells the story, attacked the beasts of burden accompanying the host of Xerxes, belonged to this species.* There is no doubt that it long survived the cave-bear.

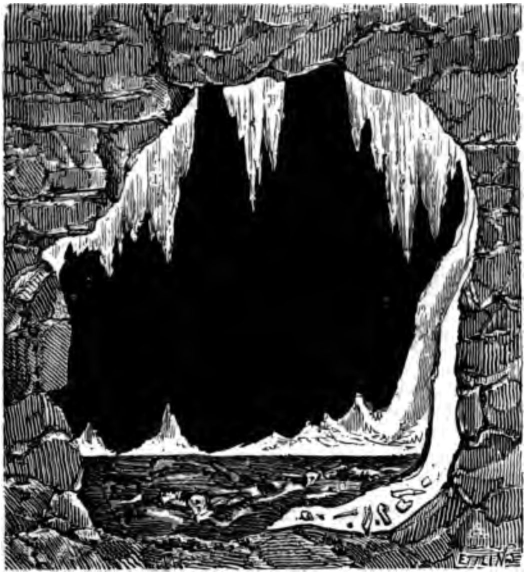


SKULL OF THE CAVE-HYENA.

In size it surpassed the living hyena, but in general structure, as in habits, closely resembled it. Enormous quantities of its bones were found in the famous cavern of Kirkdale, in Yorkshire;* the teeth alone being sufficient to furnish seventy-five individuals. It was evident that the cave had been occupied by successive generations, which had dragged their prey into its recesses; sometimes the remains of dead elephants and rhinoceroses, sometimes the carcases of weaker members of their own kind. The bones found were almost all cracked and gnawed, and had been obviously subjected to the action of hungry teeth. Soemmerring speaks of a hyena's head discovered in a cave in Germany, which was marked by

---

* Sir J. Lubbock, "Prehistoric Times," p. 238.



BONE-CAVERN OF KIRKDALE.

---

* Described by Dr. Buckland, in his "Reliquiae Diluvianae."

a severe wound, made, perhaps, by a stronger hyena, a lion, or a tiger; but the animal had lived long enough after the fight for its wound to heal.

Pikermi distinguishes three remarkable species of the Hyaenidae, or of animals akin to that family—namely, the *Hyaena eximia*, the *Hyaena chaeretis*, and the *Hyaena graeca*. The former seems to have resembled three of the living species, the spotted, brown, and striped hyena.

Thus, as Gaudry remarks, Nature seems to delight in continual variations; and yet most of these variations revolve in one and the same circle. Obviously the *hyaena eximia* and the existing hyenas belong to the same type. When we compare them, we are immediately struck by their similitude: we are almost tempted to say that the Creator has copied one from the other, except in details of minor importance. The study of the hyenas, like that of many genera of mammals, leads us to inquire whether those naturalists who regard the idea of *species* as the result of the perception of a material reality, are justified in considering the idea of *genus* as an abstraction of the intellect.

He adds that the *hyaena eximia* and the living species furnish a new proof of the difficulties we encounter when we seek to build up a fossil species out of isolated fragments. Frequently in the same species the dental branches of the under jaw vary in height—the ascending branches rise according to a very unequal incline; there exist one or two chin-holes (*trous mentonniers*); the first premolar lasts a long time, or falls out at an early date.

The *hyaena eximia* was neither so large nor so heavy as the cave-hyenas, but in size resembled very closely its living descendants. Like the other hyenas, its fore-legs were taller than its hind-legs; and from the conformation of its limbs, there is reason to believe that it did not make use of its paws to tear its prey, and that it chiefly lived on carrion.

The *hyaena chaeretis* is connected with the Hyaenidae by its canine teeth, but separated from them by its premolars. It can be placed with the hyenas only as a temporary arrangement: when better known, it may prove to be a new type; its long, straight, wide-apart premolars seem to show that its diet differed wholly from that to which the hyena is partial.

The *Hyaenictis* (from ὕαινα, *hyena*, and ἰκτίς, *a marten*) has still less connection with the Hyaenidae; for among its teeth is a small under-tubercle—a tooth never observed in the hyena, but, on the contrary, well known as a character of the family of the *Mustelidae*, of which the weasel is the type. Therefore, as its name indicates, it is an approximation of the hyena to the Mustelidae.

Thus, then, we find in two of the Hyaenidae—the *hyaenictis* and the *hyaena eximia*—the character of the Viverridae and the Mustelidae; while, on the other hand, we have found in a viverrid—the *ictitherium*—the characters of the Hyaenidae. The discoveries at Pikermi obviously tend to unite one to another those three great families.

In 1837, when the Galidia was discovered, Saint-Hilaire took occasion to make the following remarks: — "The galidia tends to link with the Mustelidae the mangoustens and the genets, and, through them, the entire group of the Viverridae, already linked through other groups with the Felidae, and by others with the Ursidae." At this time no intermediary had been discovered between the Viverridae or the Mustelidae and the Hyaenidae. Prior to M. Gaudry's researches at Pikermi, paleontology had not added a single genus to the Hyaenidae family.

"In the course of my work," says Saint-Hilaire, "I shall point out more than one analogous transition; for the unity of the world reveals itself incessantly, whether we trace created life into the different regions of the globe or through the infinite succession of the ages. If we remark at what point, in living nature, families, genera, and even species are frequently difficult to fix the limits of, we shall not fail to be struck at the sight of the fossil animals re-establishing themselves as intermediaries between existing forms of life."

V. THE GREAT CAVE-TIGER: AND THE MACHAIRODUS CULTRIDENS.

The lion and the tiger are nowadays as unknown in Europe as the hyena; and yet in the Pre-glacial period they were very numerously represented. Their size was considerably superior to that of any of the great living Felidae. The cave-tiger, or wild cat of the caverns (*felis spelaea*), was larger in bulk than our largest bulls, and fully twelve to thirteen feet in length. It was in some respects a tiger, in others a lion; or rather, from inspection of the skeleton it is difficult to determine whether it was one or the other. At all events, it swarmed of old in the woods and hollows of Great Britain; and the first discovery of its fossil remains was made in the celebrated cavern of Kent's Hole, near Torquay.

A yet more remarkable member of the Carnaria—and one, too, of the most curious registered in the records of paleontology, is the *Machairodus cultridens*. Just as the single fossil of Greece—the mesopithecus—resembles the macacus in its limbs, and is separated from them by the shape of its head, so does the machairodus connect itself through its limbs with the type of the Felidae, and depart from them in the shape of its head.

Next to the cave-tiger, it is the largest of all the Carnaria, past and present. Its generic name, *Machairodus* (sabre-tooth)—from μάχαιρα, *a sabre*, and ὀδούς, *a tooth*—alludes to the extraordinary configuration of its enormous upper canines, which resemble the blade of a poignard; its specific name, *cultridens*, has the same signification. Its frame was stronger than that of either the existing lion or tiger; but its closest relationship is with the latter. From the width of the *olécranon*, you may at once conclude how great was the energy of the exterior muscles of its fore-arm. It was capable of certain movements of pronation and supination; in other words, it could assume a crouching or prostrate position. Its paws were much stronger and heavier than those of the lion. Its phalanges exceeded in width those of the royal tiger. The unguiculated phalange of the thumb was much larger than in the cave-tiger. The strength of the bones of the thumb shows with what a fatal grasp it must have seized its living prey.

The history of the discovery of the machairodus teaches us the same lessons as those we learn from the mesopithecus. At first the only relics discovered were the frightful canine teeth. Not the less did our paleontologists undertake to determine its place in the series of animal life. To reconstruct an animal of which only one tooth is known is a *tour de force* which, in the early days of science, might flatter the ambition of its professors; but, as a French writer has remarked, the ablest naturalists have been led astray by it. And they were led astray in the instance we are now considering.

Thus Cuvier, following Nesti, classified the *machairodus* as a bear, the *Ursus cultridens.* Some years later the skull of this pretended bear was found, of this supposititious addition to the great ursine family. Lastly, Gaudry was fortunate enough to discover a large portion of the bones of the limbs; three entire *humeri,* and one incomplete; two radii in connection with their cubitus; two fore-feet, of which one retained nearly all its parts; and, finally, the tibia of one of the posterior limbs. Then it was found that the machairodus was a feline animal, though differing from its congeners in its high chin and the power of its upper canines.

It seems generally admitted that the *machairodus cultridens* made its appearance in the middle of the Tertiary epoch. And it had fully as much right to the title of "king of animals" at that epoch as the lion has to be styled the "king of animals" in the present era. No such terrible *felis* existed in the first Tertiary period: the pachyderms and ruminants whose relics have hitherto been met with in the Eocene strata have not the colossal dimensions of those of the succeeding ages, and are not so numerous; consequently the harmony of Nature did not require that the carnivora should manifest an equal potency. In contemplating, says Gaudry, the multitude and dimensions of the herbivora of Pikermi, we are not astonished to find among the deposit the *machairodus cultridens*, which presents in the highest degree the type of the animal designed to feed itself upon living flesh.

Without being too rash in my assertions, continues Gaudry, I think I can imagine this carnivore, with its sabre-shaped teeth, cutting into strips the thick hide of the pachyderms of ancient Greece.

The machairodus has been discovered in various parts of France, Italy, Hungary, and Hesse-Darmstadt, as well as at Pikermi. If the indications have in all cases been correctly interpreted, we must admit that it ranged over a vast domain, and that its existence numbered many generations.

Gaudry discovered the remains of three individuals only: in other deposits where its relics have been detected their paucity has excited attention. Nature, in the past as in the present, to maintain the economy of the animal kingdom, took care that the great carnivora should be few in number compared with the herbivora. Had it been otherwise, the former would soon have exterminated the very species on which they relied for sustenance; while, owing to the destruction of the latter, the luxuriance of primeval vegetation would have wanted one powerful means of repression.

It appears, remarks an eminent geologist, that at this epoch the whole surface of Europe was densely peopled by various orders of mammalia; that the numbers of the herbivora were maintained in due proportion by the controlling influence of carnivora; and that the individuals of every species were constructed in such a manner as to provide for the due enjoyment by each of the pleasures of existence, and to place it in its legitimate and useful relations to the remainder of the animal and vegetable kingdom.

Throughout all creation one great law is ever plainly visible in the due adjustment of its various parts—the law of Equilibrium.

CHAPTER III.

THE RODENTIA.

THE HYSTRIX PRIMIGENIUS, OR PRIMITIVE PORCUPINE.

IN the *Hystrix primigenius* we have another striking example of the little confidence to be placed in the determination of the species and genus of a fossil from a single tooth. Such an undertaking is, in fact, scarcely less ridiculous than the conduct of that Scholastikos in Hierocles at whose absurdities we all in our youth have laughed; of that Scholastikos who offered a solitary brick as a specimen of a splendid mansion.

In 1848 Wagner received from Greece, with all the enthusiasm a mediaeval monastery would have bestowed on the arrival of a saint's thigh-bone, a lower incisor tooth; and immediately set to work to establish a new genus, which he named the *Lamprodon*, and pronounced to occupy an intermediate position between the porcupine and the beaver. Soon afterwards, from the same locality, he received two molars, evidently belonging to a rodent: this time he called Roth to his council, and the two came to the conclusion that they belonged to an extinct species of beaver—the *Castor atticus.*

Thus was paleontological science enriched with a new genus and a new species.

But in 1855, among the treasures of Pikermi, Gaudry lighted upon a jaw containing both incisors and molars exactly similar to those discovered by Wagner. Thence forth the *lamprodon* and the *castor atticus* ceased to be; but in their place arose a new kind of porcupine — the *hystrix primigenius*—which seems to have closely resembled the porcupine of Southern Europe.

Wagner had the good sense to acknowledge at once the accuracy of Gaudry's definition.

Nor did M. Gaudry glorify himself at the expense of his fellow-naturalist, because he had mistaken a porcupine for an unknown genus, and for a beaver. With the isolated fragments he had at his disposal, anybody might have committed a similar blunder. But, at least, it should be a warning to naturalists against over-confidence in their imaginary reconstructions.

As for M. Gaudry's conclusion, it rests upon the portions of the skull, an upper jaw, lower jaws, and the bones of the anterior limbs which he examined.

CHAPTER IV.

THE EDENTATA.

THOSE mammals which are deficient in teeth in the fore part of their jaws are called Edentata. This is their principal characteristic; but they are also distinguished by the large size of their claws.

In the class Mammalia they form an order, which is usually divided into two families:—

1. That of *Tardigrada*, or "slow-paced"—animals with a very slow pace—such as the *aï*, or three-fingered sloth, and *unau*, or two-fingered sloth; and,

2. That of *Effodentia*, or "diggers"—animals with a long pointed muzzle—comprising the tatous, armadillos, pangolins, and ant-eaters. The two latter are the only Edentata absolutely destitute of teeth; but none of the order have any teeth in the fore part of their jaws.

The order does not include many living genera; but those of the primeval world were numerous and remarkable. Many of them were not inferior in size to the existing elephant, and their bones, distributed in immense quantities over South America, were long mistaken for the bones of giants.

But, apart from their extraordinary proportions, these animals, as we shall see, are recommended to our attention by the ambiguity of their character.

I. THE MACROTHERIUM.

In Europe only two Edentata have been discovered, and the Macrothere is one of the two.

Christened by M. Lartet (from μάκρος, *great*, and θηρίον, *animal*), the genus was erected, so to speak, out of some bones and fragments of molar teeth discovered in the deposit of Sansan.

The macrothere partook of the characteristics of both of the families which we have described. It had the unguinal phalanges of the pangolins, and the teeth of the sloths. From the construction of its fore-limbs, which were much longer than its hind, we may infer that, like the aï and the unau, it was a climbing animal.

II. THE ANCYLOTHERIUM.

This, the second Edentate met with in Europe, was found among the osseous treasures of Pikermi.

It was partly related to the macrotherium; but there was not that disproportion between its two pairs of limbs which distinguished the former: it was also endowed with greater strength, while in magnitude it surpassed all existing Edentata.

The name *Ancylotherium* (from ἀγκύλος, *crooked*, and θηρίον, *an animal*), bestowed upon it by M. Gaudry, refers to the animal's crooked claws. Among living Edentates, the sloths apparently possess some connection with the apes, and the orycteropi with the swine. The ancylothere was in like manner linked to two very different families.

Its humerus, its radius, and its tibia resembled the like bones of the rhinoceros; its metatarsi, and the pieces of the tarsus connected with them, recall the mastodon type; while several other parts of its limbs present marked affinities with those of the pangolins and the macrotherium.

It was a larger animal than the rhinoceros. Its forms were more shapely than those of the American fossil Edentates, but heavier than those of the macrothere. Its crooked claws must have given it a singular gait, and would have rendered progression very difficult, but for a provision which enabled it to retract them upon its metacarpi and metatarsi. We know that carnivorous animals of the genus *cat* present an analogous conformation; only it is not the entire claw which they retract, but simply the unguiculated phalanges.

Undoubtedly the macrotherium made use of its fore-feet with little dexterity, and it must have been incapable of climbing.*

An important reason for ascribing to the Edentate of Greece a different gait from that of the Edentate of France is, that in the former, the ancylothere, the hind-limbs are nearly equal to the fore-limbs, while in the macrothere they are extremely short; the latter would seem to have crouched on its hind-quarters. So great a difference of attitude necessarily implies a difference in its habits of life; it is with difficulty we picture to ourselves an animal so disproportioned as the macrotherium living on a level surface, while we may imagine our gigantic Edentate marching erect on its four feet in the plains as well as the highlands of Attica.

---

* On this point M. Gaudry remarks with much justice: "The characters furnished by fossil bones prove that an animal was *endowed* with certain faculties, but *not* that it made use of them. If, for example, we found in the fossil state the skeletons of a tamandua and a tamanoir, we should infer from our examination that both possessed the power of climbing, but we should not be able to divine that the tamanoir lived habitually upon the ground, while the tamandua not less habitually roamed among the forest trees."

III. THE GLYPTODON.

The *Glyptodon*, so named by Professor Owen (from γλύπτος, *sculptured*, and ὀδούς, *a tooth*), may be described as the armadillo of the primeval world. But it differed from the living animal in not possessing any bands or joints in its coat-of-mail, so that it might contract or coil up its body into a ball-like shape. Its name refers to the fluted configuration of its teeth, each being divided into three parts by two deep longitudinal clefts. It had eight of these teeth on each side, and in both jaws. Its food was composed of roots and vegetable refuse.

A diminutive specimen of this remarkable genus measured from the snout to the end of the tail, following the curve of the back, nine feet; the tesselated trunk-armour, or carapace, which covers its body, being five feet long and seven feet wide. Its shell, in which it must have presented almost as uncouth an appearance as Sancho Panza in his coat-of-mail, or Goose Gibbie in his celebrated jack-boots, consisted of numerous round or many-sided pieces, fitting into one another very closely, and united by indented sutures; the tail and head were covered as well as the trunk.

The framework of the foot was so contrived as to have no parallel in the whole animal kingdom. It was admirably adapted to form the base of a column capable of supporting a vast superincumbent weight, and yet to allow that mobility of the anterior extremities requisite for the scratching and digging operations of this primeval armadillo. And hence we may infer that the glyptodon's "mission" in nature was to consume and clear away the dead animal and vegetable matter, whose accumulation might otherwise have charged the air with noxious gases.

The earliest mention of the glyptodon occurs in Falkner's "Description of the Magellanic Lands," published in 1770, where we find it recorded that the author had discovered, in the Pampas, a shell resembling the carapace of the tatou, but much larger, and composed of bones of an hexagonal form, each an inch in diameter. He describes the carapace as nine feet in length. But it is not improbable that the Jesuit missionary indulges here in a little exaggeration, says M. d'Archiac; and there is still more reason for thinking so of Manoel Ayres de Cazal, who would have us believe that he found, near Rio das Contas (in Brazil), the cuirass of an animal upwards of thirty feet in length.

We have seen that, however extravagant the estimate of De Cazal, that of Falkner was by no means open to objection.

Sixty years passed by without any confirmation of this discovery. Then, in 1833, a carapace similar to the one described by Falkner, but of smaller dimensions, was found in Monte Video, and became the theme of a very animated controversy. For as it was found in the deposit which had yielded the bones of the megatherium, another Edentate, known long before this epoch, some authorities asserted that it belonged to this animal. Scientific disputes are usually protracted to a wearisome length, and the present did not terminate until the buckler of the glyptodon had come to light in connection with the bones of the animal it had formerly covered.

The two recognized species of this remarkable animal are,—

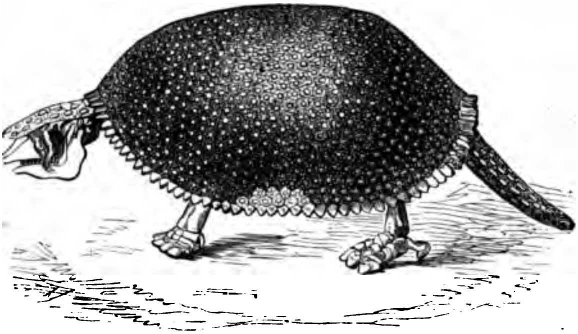
1. The *Glyptodon clavipes;*
2. The *Glyptodon ornatus.*

Of the former species a skeleton, nearly entire, may be seen in the Museum of Natural History at Paris. Its total length is about 3 feet 6 inches; its height, from the ground to the top of the iliac ridges which carried its carapace, is 1 foot 3 inches.

Undoubtedly this individual is the most complete specimen yet seen in Europe. Its head, which paleontologists had previously been compelled to describe from fragments belonging to different individuals, is entire. It is remarkable for its vertical diameter, compared with its horizontal, the two being nearly equal—that is, between nine and eleven inches. This elevation of the head is owing to the development of the maxillary bones.

Apparently the teeth were of a very moderate size. They are worn down almost to the level of the gums. But each sinks into its socket to the depth of 4 inches at the least.

The most interesting and, at the same time, the most unusual region of the glyptodon's skeleton is the neck and upper part of the thorax. For the neck is thus composed: its first vertebra (atlas) is free; the second, third, fourth, fifth, and sixth are united, and form what a French geologist has named the *pentavertebral bone;* the seventh is united to the first dorsal, which, in its turn, is united to the second dorsal—the three being named by Professor Huxley the *trivertebral bone.*



THE GLYPTODON CLAVIPES.

The composition of each of these two bones reminds the anatomist of the structure of the human sacrum, which is, as everybody knows, formed of five vertebrae linked together.

A curious hinged articulation, which exists on the posterior surface of the trivertebral bone, enables the latter to move on the third dorsal, like a trap-door on its hinges.

The articulation of the pentavertebral bone with the trivertebral is marked by an analogous arrangement.

When these two articulations of the neck of the *glyptodon clavipes* are brought to coincide in a mean position, the axis of the vertebral column, instead of describing like other vertebrae a more or less broken curve, is twice diverted at an angle, so that the axis of the neck, horizontal like that of the dorsal column, is yet in an inferior plane.

These two planes are connected by the trivertebral bone, which descends from the third dorsal to the sixth cervical, following a nearly vertical line, slightly inclined forward.

Whether the animal could butt with its muzzle, like the ram with its forehead, is a question as yet undetermined.

The *Glyptodon ornatus* was of smaller dimensions than the preceding. But the fragments we possess of it are few and very imperfect; and while you may see in the Museum at Paris the entire skeleton of the *glyptodon clavipes*, of its congener you can find only the carapace. This, however, has not required to be reconstructed piece by piece. A few reparations have sufficed. And we see it now in the same condition as when it protected the living animal; and it has preserved even its normal relation with the bones of the pelvis.

The configuration of the neck seems to have differed from that of the neck of the *glyptodon clavipes.* Instead of a trivertebral bone and a pentavertebral, the *glyptodon ornatus* had two bones of four vertebrae each.

IV. THE MEGATHERIUM.

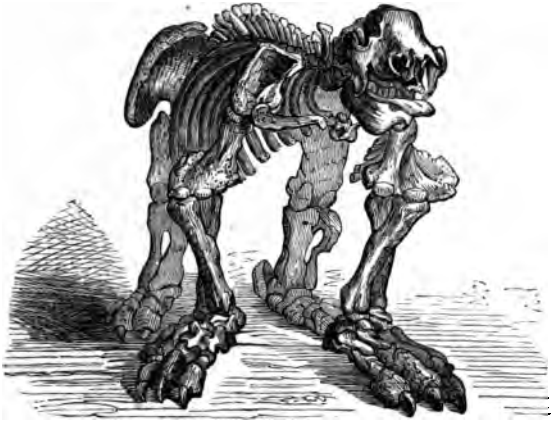
The *Megatherium*—that is, the Great Animal (from *μέγας*, *great*, and *θηρίον*, *animal*)—belonged to the order Edentata, and was nearly allied to the modern sloth, though constructed on a larger scale. In fact, it might briefly be described as a gigantic sloth, eighteen feet in length, by nine feet in height. In the general proportions of its body, however, it resembled the hippopotamus; but its trunk, much more colossal than that of any hippopotamus, was terminated by a pelvis, and by posterior limbs nearly three times as large as those of the hugest elephant. These hind-legs were provided with feet set, as in the bear, at right angles to the leg; the heel projected nearly fifteen inches backwards, and the five toes, furnished with strong claws, protruded more than twice that distance forwards, affording a firm base on which the mighty monster's bulk might rest. But it also owned an enormously massive tail, depending to the ground; and it is probable that this appendage assisted in supporting the broad termination of the pelvic region.

The fossil remains of the megathere have been found only in America. They are very numerous in the alluvial deposits of Paraguay; and hence the name of "Animal of the Paraguay," bestowed upon it by geologists when it was first discovered, towards the end of the last century.

Cuvier says of it, briefly,—"Its analogies refer it to various genera of the family of the Edentata. It has the head and shoulder of a sloth, while its limbs and feet present a singular combination of the characteristics peculiar to the ant-eaters and the tatous."

The thigh-bone resembled that of the pangolin. The tibia and the fibula were united at either end, as in the tatou.

The skull was in singular contrast to the other parts of this animal-colossus. It was exceedingly long and narrow, and connected with the trunk by a neck of moderate dimensions. The whole body gradually tapered forward from the enormous pelvis and gigantic hind-quarters; in this respect resembling the other species of the Edentata.



SKELETON OF THE MEGATHERIUM.

The teeth of the megathere were wonderful examples of the powers of contrivance and design of the Divine Architect.

They were about seven inches long, and slightly curved. All were molars, or grinding teeth; and four were set on either side of the lower jaws, five in the upper. Their grinding surface was simple, and well adapted for crushing and triturating leaves and twigs. They consisted of regular four-sided prisms, the outer coating being of bony matter, enclosing a thin inner plate of enamel, and a central mass of ivory; while the opposing teeth were so placed in the jaw that the enamel of each cut into the softer bone and into the central ivory of the corresponding one. Thus a grinding surface was constantly and evenly preserved, and two wedge-shaped cutting edges worked into one another, and kept one another sharp.

Dr. Buckland remarks that the same principle is applied by tool-makers, for the purpose of maintaining a sharp edge in axes, scythes, bill-hooks, and similar implements. An axe or bill-hook is not made entirely of steel, but of one thin plate of the metal, inserted between two plates of softer iron, and so enclosed that the steel projects beyond the iron along the entire line of the cutting edge of the instrument. By this contrivance a double advantage is secured: first, the instrument is less liable to fracture than if it were made entirely of the more brittle material; and, secondly, the cutting edge is more easily kept sharp by grinding down a portion of exterior soft iron, than if the entire mass were composed of hard steel. By a similar arrangement, two cutting edges are produced on the crown of the molar teeth of the megatherium; and hence its mouth became an engine of tremendous power, in which its sixteen molar teeth furnished two-and-thirty powerful wedges; each tooth being from seven to nine inches long, and having the greater part of this length fixed firmly in a socket of great depth.

In the steam-engine we are accustomed to admire, not alone the power, simplicity, and exquisite mechanism of the whole, but the accurate adaptation of each part to a particular purpose, and the harmony of proportion which distinguishes the minutest details. It is so with the megathere. Wonderful as are its bulk, its strength, and its general fitness for its special mission, equally wonderful is each part of the gigantic structure in the manner in which it discharges the functions required of it. The ribs are broad, so as to offer a firm support to the animal's body; and those which form the breastbone are locked, as it were, together, apparently to assist these huge creatures in burrowing through the earth. In the posterior portion, commencing with the lumbar vertebrae, and including the bones of the pelvis, the tail, and the hinder extremities, there is a marvellous succession of contrivances to secure the utmost possible strength; and the body of the megatherium may aptly be compared to a wedge, the massiveness of the broad hinder part being intended to assist the animal in forcing its way through any resisting object. The bone stretches out from each side of the spine to a distance of five feet, forming a large abdominal cavity, adapted to the habits of the animal as a vegetable feeder. Stalwart bones, set at right angles to the spine, and vertically over the hind-legs, compose a solid mass, able to endure almost any amount of pressure, and so constructed that the hind-legs could support uninjured any efforts the megathere might make when posed upon its hinder extremities and tail, as on a tripod.

Similar ingenuity, if we may use the word, is visible in the structure of the huge columnar legs. So, too, in the tail, which must have been of considerable length, certainly not less than five feet. The fore-legs equally claim our admiration; while to the enormous breadth of the shoulder-bone we have already alluded. "It is small," says an accurate writer, "in the middle and upper part, and is connected with the blade-bone by a round head, fitting into a socket, and admitting of free motion. At the lower end, however, where it is attached to the arm-bones, it attains an immense breadth, and served for the attachment of muscles of extreme and unusual magnitude, working the fore-foot. The use of this expansion will be obvious if we compare the shoulder-bone of a ruminating animal, where the crests are scarcely observable, with the corresponding bone in the elephant and rhinoceros. In the ant-eater this contrivance is carried yet further, and by its means the animal is greatly aided in digging up the large solid nests of the white ant. The bones articulated to the large termination of the shoulder-bone correspond well in magnitude and strength. The one is broad, powerful at its upper end, and short; and the other revolves freely upon it, giving that motion of the fore extremity by which man is able to move his hand on either side by a simple motion of the wrist."

The megathere's fore-foot must have been about three feet long and one foot wide. It was provided with five toes, three of which were very large, and all of which were armed with long and powerful claws.

Such being the colossal structure of the megathere, and such its peculiar position in the economy of creation between the sloth, the armadillo, and the ant-eater, one is necessarily led to inquire, what were its habits? Its tremendous size must surely have unfitted it to burrow like the mole or the armadillo, or to climb trees like the sloth? If, as some geologists suppose, it was cased, like the armadillo, in a coat of armour, it could certainly neither run nor leap, and all its motions must have been slow and deliberate. But what need of swiftness to escape its foes? A creature of such dimensions, clad in an impenetrable cuirass, and able by a single stroke of its paw to demolish either the cougar or the crocodile, must have scorned the attack of any enemy whatsoever. It has been suggested that it procured its food by digging up succulent roots; but in that case its enormous strength, and the vast mechanism of its frame, would, so to speak, have been wasted. Let us avail ourselves of Professor Owen's guidance to visit a primeval forest, and watch the monster in his movements. We shall then see how it fared for nutriment.

Stalking with heavy tread through the brushwood, he advances towards a tree of majestic stature. For a while he pauses before it, as if doubting whether, after having braved the storms of so many winters, it will yield even to his Titanic strength. But soon his resolution is taken. Having addressed himself to the task, he first loosens the soil around the tree to a great depth by the powerful claws on his fore-feet, and when a sufficient excavation has been made, he plants himself carefully on his monstrous hind-feet and scarcely less monstrous tail, so as to provide a sturdy basis for his body. Then lifting himself up, like a huge kangaroo, he grasps the tree with his fore-legs, at as great a height as possible, and firmly grapples it with his muscular trunk, while the pelvis and hind-limbs, animated by the nervous influence of the unusually large spinal cord, combine all their forces in the effort about to be made. And now conceive the massive frame of the megathere "convulsed with the mighty wrestling, every vibrating fibre reacting upon its bony attachment with the force of a hundred giants!"

The tree reels to and fro, like a ship in a storm; for a while it withstands the assaults of its pertinacious foe; but at length it yields—it topples over—it comes down with a crash, and the megathere proceeds to strip off its green twigs and juicy shoots "in measureless contentment."

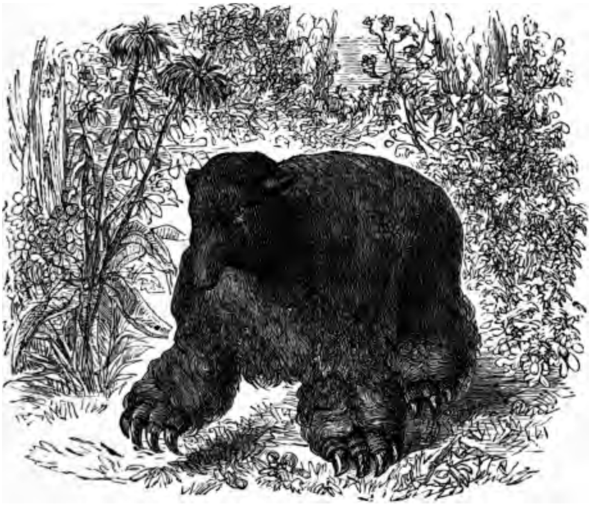
Sometimes, however, the tree in falling will crush its ponderous assailant. To guard against this risk, the most exposed part, the skull, is strongly defended. It is more cellular than is usual with other animals, and the inner and stronger plate is covered with an outer table of bone, and with intermediate walls, to resist a sudden and violent shock.*

It was at one time supposed that the megathere's body, like that of the tatou, was protected by an osseous cuirass. Buckland, among other eminent geologists, held this opinion; and as certain ribs of the animal have a rugose upper surface, he thought that it was on these the buckler rested. But he was mistaken; and, as we have seen, the carapace attributed to the megatherium really belonged to the glyptodon.

---

* Buckland's "Bridgewater Treatise on Geology."

We first hear of this extraordinary animal in 1789, when a nearly complete skeleton was discovered on the bank of the river Lujan, about three leagues from Buenos Ayres, and at an elevation of thirty-three feet above the sea-level. It was sent to Spain by the Marquis de Loretto, then Viceroy of Buenos Ayres. Soon afterwards, two more specimens were exhumed, one at Lima, the other in Paraguay, of which the former was also despatched to Spain in 1795. Owing to the rare circumstance that nearly all the animal's bones were found in one deposit, and were reconstructed immediately, the



THE MEGATHERIUM, RESTORED.

osteological details of our extraordinary mammal became known almost immediately. A writer at Madrid published a description of it in 1796. In the preceding year, Cuvier, basing his decision upon the imperfect drawings he had received, had classed it among the Edentates, as a congener of the sloths.

Many years later, Pauder and Dalton having, during a tour in Spain, studied at Madrid itself the skeleton of the megathere, were able to furnish a more detailed description, which was published at Bonn in 1821. So far as the animal's classification was concerned, they adopted Cuvier's point of view, and they named the fossil *Bradypus giganteus*, or Giant Sloth—a name which had been suggested by the French naturalist.

Blainville, on the other hand, was of opinion that the megathere approximated much more closely to the tatou, the orycteropus, the ant-eater, and the tamanoir, than to the sloth; and nowadays it is placed, as he would have placed it, among the ordinary Edentates. But to whatever group we refer it, an impartial examination shows that it is not exactly fitted for any special place; it was and is an animal *sui generis*.

The designation by which it is now best known, that of the megathere, was bestowed upon it by the Spanish authors; and it is rendered specially appropriate by the animal's colossal bulk.*

---

* It will be observed that we frequently make use of the English adaptation of the original scientific name, as *Megathere* for *Megatherium*. We wish it were possible to get rid altogether of the uncouth forms introduced by our paleontologists.

V. THE MEGALONYX.

Cuvier pithily says of the Megalonyx that it bore a great resemblance to, but was somewhat smaller than, the megathere. In fact, its size was about that of a very large bull. If not so huge, it was also not so unwieldy, as its formidable contemporary.

Its muzzle was pointed; its jaws were armed with cylindrical teeth; its fore-legs were much longer than its hind-legs, in which respect it resembled the sloths; its short toes were furnished with enormous claws; the foot was articulated obliquely to the leg; the tail was thick and solid.

This animal received its name in 1797, from Mr. Jefferson, President of the United States. His illustrious predecessor, George Washington, having informed him that the bones of an unknown animal had been discovered in Green Briar Cavern, West Virginia, Jefferson hastened to procure them. They consisted of a femur, a radius, a cubitus, three claws, and some few bones of the extremities.

Having compared them with the analogous bones in the lion, Jefferson formed the opinion that they had belonged to a great carnivore, which he named the *Megalonyx*, on account of the size of its claws. He surmised that it must have been at least five feet in height, and that the mastodon itself must have found it a formidable enemy.

Cuvier, however, discovered its true place in the economy of the animal kingdom, and, relying on the conformation of its unguinal phalanges, classed it among the Edentates. In this family the articulation of the phalange is so arranged that the flexion takes place underneath, while exactly the opposite is true of the carnivorous Felidae. Through the inequality of its phalanges, moreover, the megalonyx is separated from the Carnivora; but this also divides it from the sloths, to bring it nearer to the tatou and ant-eaters.

The ancient Edentates inhabited the forests of the Western World, and flourished chiefly in what is known as the Post-Pliocene period.

VI. THE MYLODON.

In all the mammals we have hitherto described, the fingers could bend or fold, in a greater or lesser degree, around the objects they wished to seize; they were able also to feel them, the claw which armed them leaving their extremity uncovered for a somewhat considerable extent. The limbs of these animals, therefore, served a double purpose; they were not only organs of sustentation and locomotion, but also, more or less perfectly, of prehension and touch.

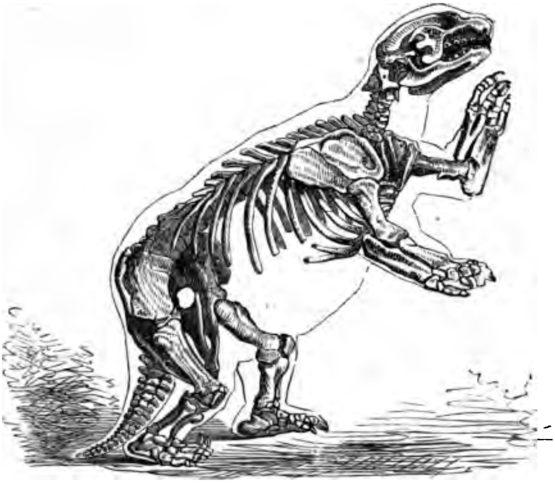
But, on the contrary, in the mammals of which we shall have to speak when we have done with our group of Edentates, the fingers cannot bend, and their extremity is entirely occupied with a great claw or hoof, which completely deadens the sense of touch. In these animals the limbs are only organs of support and locomotion.

The former are now named *Unguiculated Mammals.*

The latter are known as *Ungulated Mammals.*

Now, according to a remark of Professor Owen's, the mylodon forms a link between these two classes. On each foot it was armed with claws like the unguiculated, and hoofs like the ungulated mammals.

The mylodon is found in the same formations as the megalonyx and the megatherium, but it was much smaller than either, and differed from them in its dentition. It possessed the same number of teeth as the megatherium —four molars on each side of the lower, and five on each side of the upper jaw—but these teeth were not alike. Their smooth and worn surface indicates that it fed upon vegetables, and it is supposed that it preferred the young leaves and buds. It is generally represented, therefore, as standing erect against a tree, and stripping it of its foliage.



THE MYLODON ROBUSTUS.

Three species of this Edentate have been distinguished by naturalists. They were inhabitants of the Pampas of Buenos Ayres.

CHAPTER V.

THE RUMINANTS.

THE RUMINANTS are arranged in seven families: the *Camelidae*, the *Moschidae*, the *Cervidae*, the *Camelopardidae*, the *Antilopidae*, the *Bovidae*, and the *Capridae*. They derive their general appellation from their habit of rumination; that is, of chewing the cud. In the upper jaw they have no incisors, but the front is occupied by a callous pad. By means of their long and movable tongue, the grass is collected and rolled together; then, with some assistance from the upper cartilaginous lip, it is firmly held between the pad and the lower cutting teeth, and by a sudden "nodding motion" of the head, the little roll of herbage is either torn or cut off, or partly both torn and cut.

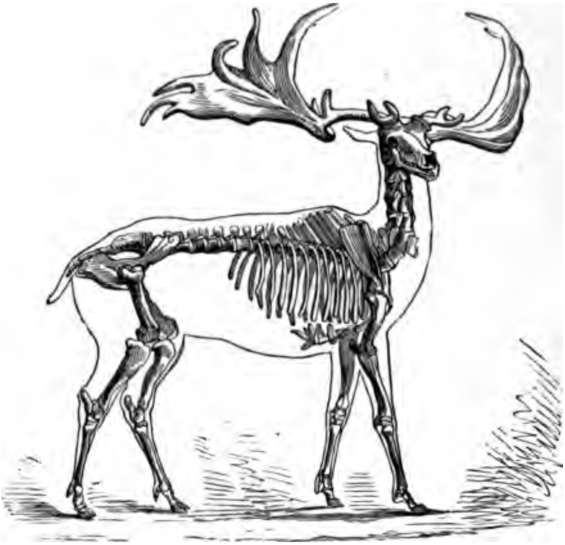
The head, in the Ruminants, is always elongated, the neck of considerable length, the eyes are situated at the side, and their senses of sight, smell, and hearing are very keen. In many genera the head is armed with horns; these differ greatly in their structure—some being hollow, or *true horns*, others solid, or *antlers*. The legs are rather long, the brain is small, and the spinal column particularly flexible.

The stomach deserves attention from its complexity. It consists of four distinct sacs or cavities: the first and largest is called the *paunch* (Lat., *rumen*), and receives the chief part of the food; the second, the *honeycomb bag* (*reticulum*), affords a channel for fluids; the third is the *maniplies* (*psalterium*), so called from the many folds of its membraneous lining, which seem to absorb all superfluous fluid from the food; and the fourth, the *red* (Lat., *abomasum*), secretes the gastric juice.

I. THE CERVUS MEGACEROS, OR GREAT-ANTLERED STAG.

The most celebrated of the primitive Ruminants is the *Cervus megaceros*, the Great-Antlered Stag, or Irish Elk. Its remains have been found abundantly in the immense peat-bogs of Ireland; sometimes in the underlying deposits of calcareous tufa; sometimes in the turf itself. In the latter case, they are generally discovered in little mounds, and nearly always in the same attitude, the head raised, the neck stretched out, the horns reversed and inclined towards the back, as if the animal, being suddenly immersed in marshy soil, had flung up its head in a desperate search after respirable air.

The Irish elk has been also found in Italy, Poland, Germany, and France. An entire skeleton, discovered in a marl-pit in the Isle of Man—a marl-pit filled with fresh-water shells to a depth of sixteen to eighteen feet—shows that this handsome animal more nearly resembled the stag in figure than the elk. The skeleton we speak of is now preserved in the Edinburgh Museum of Science and Art. As no specimens have been discovered without horns, Cuvier has conjectured that in this case, as in that of the reindeer, both sexes wore the same magnificent ornament.



THE IRISH ELK.

Sir John Lubbock reminds us that in the "Nibelungen Lied" of the twelfth century a mysterious animal is mentioned under the name of *schelch*,—

> "After this he straightway slew a bison and an elk,
> Of the strong uri four, and one ferocious schelch."

And it has been supposed by some authorities that this was the *cervus megaceros*. But for such an hypothesis no foundation exists; and we must remember that the same poem, as Dr. Buckland has pointed out, contains allusions to fire-dragons, pigmies, dwarfs, and giants. We must not refer to it as a safe guide in our paleontological researches. The Irish elk, undoubtedly, co-existed with man; but as it is not mentioned by Caesar or Tacitus, neither of whom would have omitted so remarkable an animal had they been acquainted with it, we must conclude that it belonged to the flint-age, and was a contemporary with the cave-bear and the cave-tiger. No remains, says Lubbock,* have yet been found in association with bronze, nor, indeed, are we aware of any which can be referred to be the later, or Neolithic age.

Hugh Miller, in one of his picturesque books, remarks that the group of mammals in what was formerly called the Quaternary Period, seems to have been everywhere a remarkable one, but more particularly so in the British Islands. Associated with species that still exist in the less cultivated parts of the country, such as the badger, the fox, the wild cat, the roe, and the red deer, are found the remains of great animals, whose congeners, if sought for anywhere, must be sought in the intertropical regions. "Britain," he says, "during the times of the boulder clay, and for ages previous, had its native elephant, its two species of rhinoceros, its hippopotamus, its hyena, its tiger, its three species of bears, its two species of beavers, its great elk, and its gigantic deer. Forms now found widely apart, and in very different climates, met within the British area. During at least the earlier times of the group, the temperature of the island seems to have been very much what it is now. The British oak flourished on its plains and lower slopes, and the birch and Scotch fir on its hills. And yet, under these familiar trees, the lagomys, or tailless hare, a form now mainly restricted to Siberia and the wilds of Northern America, and the reindeer,* an animal whose proper habitat at the present time is Lapland, were associated with forms that are now only to be found between the Tropics." †

---

* Sir J. Lubbock, "Pre-Historic Times," p. 240.

The elk must have been an animal of peculiarly striking appearance. Its horns were from nine to eleven feet from one extremity to the other.

II. THE SIVATHERIUM.

One of the largest, and certainly one of the most curious, of all fossil Ruminants, is the *Sivatherium;* so named by Messrs. Cautley and Falconer, who discovered it in the Eocene strata of the Sivalik Hills, a spur of the Himalayas.

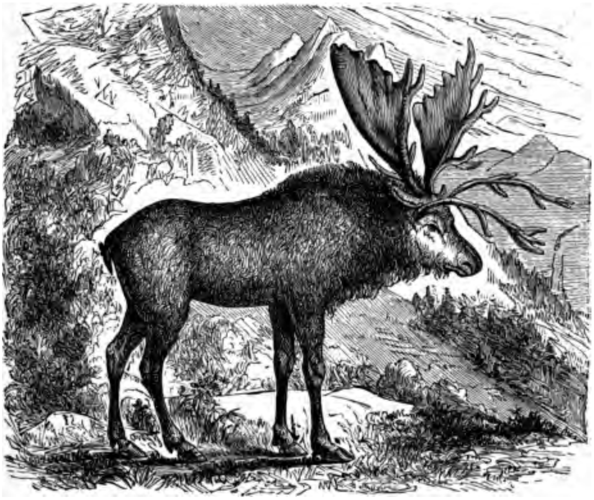
D'Orbigny describes it as forming a natural transition between the great Pachyderms and the Ruminants: in truth, while presenting the horns which characterize the majority of the animals of this latter order, the head was probably furnished with a trunk like that of the Proboscidae; at least, if one may judge from the form of the nasal bones, which are raised up and prolonged into a kind of pointed vault above the external nostrils.

The supero-posterior portion of the sivathere's skull has many points of analogy with the same part in the elephant; and the whole head was nearly of the same size as the head of the latter. In stature, too, it equalled the elephant. It differed also from the ordinary stag by its antlers, which were four in number. Two started from the brow between the orbits, and separated from one another; two others, shorter and more massive, were planted on the conspicuous protuberance of the supero-posterior part of the skull.

---

* There seems reason to believe that the reindeer's appearance in Europe took place at a later date than that of the Irish elk.

† Hugh Miller, "Testimony of the Rocks," p. 93.



THE SIVATHERIUM, RESTORED.

The face was short; a circumstance which, joined to the form of the nasal bones, and the very inclined direction of the face and forehead, contributed to give to the head one of the most singular forms it is possible to imagine.

Its upper molar teeth—and no others have as yet been discovered—show all the characteristics of those of Ruminants.

The general appearance of the sivathere was that of the elk, but it was larger and more compact. The proportions of its skull and cervical vertebrae were exactly the reverse of those in the giraffe, from which also this "huge pachydermoid antelope" differed in the horny sheaths of the horn-cores.* It closely resembled the *Brahmatherium*, a hollow-horned Ruminant found in the island of Perim; but in the latter the front pair of horns was the longest and largest. Both animals belonged to the older Pliocene period.

The sole representative of these great four-horned Ruminants is the little *Antilope furcifera.*

III. THE PALAEOREAS.

The Latin name of the Antelope canna which inhabits the vicinity of the Cape of Good Hope is *Oreas.* Hence, the primeval antelope has been designated the *Palaeoreas* (from παλαιός, *ancient*, and *Oreas*).

If the reader would fully understand the interest attaching to this fossil, he must remember, in the first place, that the antelopes are divided into several sub-genera.

One of these sub-genera contains, among other animals, the gazelles.

Another the bubalus, the gnu, and the oreas.

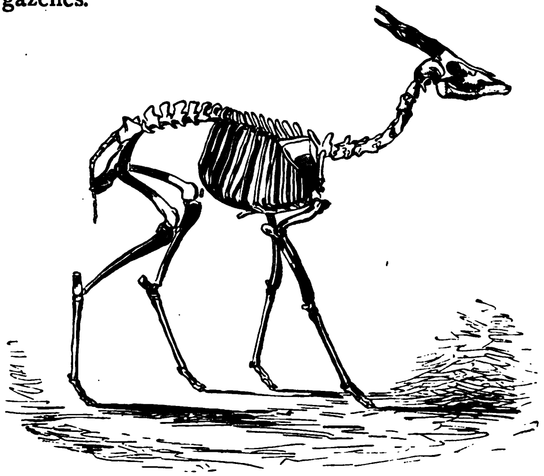
Now, to both of these sub-genera does the palaeoreas in some wise belong.

---

* Professor Owen, "Paleontology" (ed. 1861), p. 410.

In the arrangement of its horns it claims kinship with the oreas.

In most other characters it evidences its relation to the gazelles.



SKELETON OF THE PALAEOREAS.

In vain, says Gaudry, the creator of the genus to which we refer, do we attempt our classifications; every day the fossils throw ridicule on our ambitious efforts.

Somewhat larger than the gazelle, with slender figure, and the brow ornamented with gracefully winding horns, we may well imagine that the Fauna of ancient Greece could not boast of a more charming creature. It probably lived in numerous troops, since the researches of M. Gaudry have procured thirty-six skulls of the animal, without counting a great number of jaws and different bones.

IV. THE TRAGOCEROS.

We have seen that the palaeoreas establishes a link between two sub-genera of antelopes: the *Tragoceros* does more.

It establishes a transition between two *genera*, between the genus Antelope, and the genus Goat.

Resembling the goats in the external form of their horns, it resembles them in its other characters, and, among the rest, in its teeth. But nothing can give a clearer idea of the ambiguity of its characters than the following facts:—

In 1854 Roth and Wagner described, in one and the same monograph, on the one hand, the horns of some Ruminants, and on the other, a lower jaw which had likewise belonged to a Ruminant.

Of the horns they said: "Their structure shows that the animal to which they belonged was similar to the goat in character; and though we do-not know the form of its molars, we have no hesitation in ranking it in the family of the goats." And they christened it *Capra Amalthea.*

But the lower jaw they referred to an antelope, which they called *Antilope Lindermayeri.*

Now, as Gaudry has proved, these goat's horns and this antelope's jaw were the horns and the jaw of one single Ruminant—the *Tragoceros Amaltheus.*

But more: the two German anatomists have attributed to an antelope, named by them *Antilope speciosa,* an upper jaw, which the French paleontologist asserts to be that of the Tragoceros.

"I have proposed," he writes, "the name of *Tragoceros Amaltheus* (τράγος, *goat*, and κέρας, *horn*) for this animal, which, with horns apparently resembling those of goats, has not only the teeth, but also all the other characters of antelopes. It was very common in Greece; I have collected twenty skulls, and a multitude of various fragments belonging to some fifty individuals."

This curious fossil recommends itself to the attention of the paleontological student not only by its mixed characters, but also by the important variations discernible in the numerous representatives of its species which have been exhumed at Pikermi; variations which one would have judged to be *specific*, if one had not possessed the whole series of intermediary forms.

V. THE PALAEOTRAGOS.

The *Palaeotragos*, or "primeval goat" (from παλαιός, *ancient*, and τράγος, *a goat*), was another animal discovered at Pikermi by Gaudry, and, like so many other fossils, it presents a very curious association of characters.

It has horns like the antelopes, but these horns are separated from each other by a considerable interval, such as one never sees in any of the great living antelopes.

Its molars, normal as to their number, resemble those of the stag and the giraffe.

The skull, very long, and of a rectangular form, is considerably narrowed at the posterior portion; and the occiput is so contracted as to recall the conformation of the ass.

Finally, the contraction of the condylus and of the occipital orifice leads us to suppose that the atlas was narrow; that the neck, perhaps, was as slender as that of the giraffe; and that the head, as in that animal, possessed a tolerably extensive faculty of rotation upon the neck.

VI. THE HELLADOTHERIUM.

Remains of a large Ruminant resembling the giraffe in the proportions of the lower jaw, and in the secondary modifications of the grinding teeth, have been discovered in the old Pliocene deposits of Greece and southern France. Its limbs were as long as those of the modern giraffe; but it had no horns, and in other respects seems to have been allied to the more normal families of Ruminants. As one of the most characteristic Mammals of ancient Hellas, Gaudry proposed to erect it into a distinct genus, which he calls *Helladotherium* (from Ἑλλάς, and *θηρίον*).* It was a transitional form, however, occupying a place between the antelope and the giraffe.

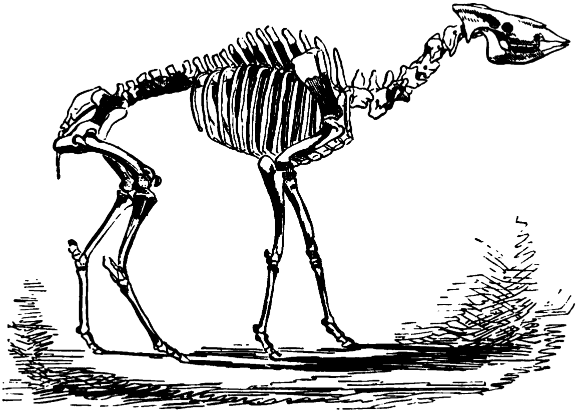
We have said that it had no horns; but perhaps we are scarcely warranted in making so definite an assertion. The only skull which has been discovered is certainly without a vestige of horns; but it is possible that this skull belonged to a female, and that though the female had no horns, the male had.

Besides the above-mentioned skull, Pikermi has furnished numerous bones of the animal's limbs, vertebrae, and other relics. The comparative study of these remains shows that the helladothere approximates to the giraffe, in the elongation of the parietal region of the skull, the hollowing of the occiput, the disposition of the chest, as well as of the mesopterygoidal fossa, and the length of the radius; but is distinguished from it by the absence of horns, the width of the face, the size of the teeth and their simplicity of structure, the shorter neck, the more massive form of every part of the body, the separation of the cuneiforms, and the lesser inequality between the height of the fore and the hind shoulders.

---

* "Comptes Rendus de l'Académie des Sciences," 1860.

The molars of the helladothere, the proportions of its neck, and the separation of its two cuneiforms, are points of resemblance to the antelopes.



SKELETON OF THE HELLADOTHERIUM.

But it is *un*like them in the greater elongation of its fore-limbs compared with its hind; by its cubitus more thoroughly united to its radius; by its hornless head, which is surmounted by a parietal protuberance, and hollow in the occipital portion.

M. Gaudry states that the modelling of a skull in the collection of Indian fossils presented to the Museum of Paris has a striking general resemblance to that of the helladothere, and is, moreover, of the same size. It is true that its pre-molars are somewhat larger comparatively than the rear-molars; its palatine fosse advances less, its occipital condyles are not so strong, the posterior face has no deep depression on each side of the occipital ridge. But if we allow for the variations an animal would undoubtedly undergo in passing from Europe into Hindustan, we shall assuredly be disposed to refer the skull of which I speak to the Grecian genus. Mr. Falconer, after a careful examination of the Parisian collection of fossils, came to the same conclusion.

You may seek vainly in living nature for any animal which will give you an idea of the helladothere. Its head was heavy, like that of a bull, but was longer, and had no horns. Its enormous teeth resembled—in shape, but not in size—those of several antelopes. Its neck was almost identical in proportions with that of the megaceros. Stouter its limbs were than those of ox or camel, but inferior in height. The fore-shoulder was upwards of six feet high; somewhat higher, that is, than the hind-quarters. Though this inequality was less conspicuous than in the giraffe, there necessarily resulted from it a gait differing considerably from the movement of stags and antelopes, whose hind-limbs are, on the contrary, more elevated than their fore-limbs.

We may reasonably suppose that, like the giraffe and the horse, the helladothere defended itself against its enemies with its hoofs, also employing against them its head as a ram, in the usual fashion of the Ruminantia.

Its blows must have been terrible, judging from the immense power in the extensor and flexor muscles of its cranium which it evidently possessed.

On what did it feed?

Here observe that the molar teeth of the Ruminantia present two principal types. In the one case they are uniform, regular, and, compared with the size of the head, very large; have no interlobar columns, or, if they have, these columns adhere to their base. It would seem that in designing them the Author of Nature's sole object was to constitute the broadest possible triturating surfaces. As examples of animals with this mode of dentition, I may refer to the ox and several species of antelope; and these live mainly upon herbage.

In the other case the teeth are not so uniform; their edges project, and on the side opposite the outer ridge they are distinguished by interlobar columns, entirely distinct from the base, which are useful in dividing and cutting the branches and young shoots. The triturating surface is less extensive. As examples, take the giraffe and the stag, which feed entirely upon trees.

In the structure of its molar teeth, the helladothere differs from the latter and approximates to the former, wherefore we are inclined to believe that the grasses formed their customary food. Moreover, if the giraffe, with its long neck and extremely tall limbs, gathers the leaves of the great trees, the helladothere, with its shorter neck and limbs, would certainly seek its nutriment much nearer the ground.

Gaudry found at Pikermi, in the course of his extraordinary researches, the remains of eleven individuals; and he was therefore led to the conclusion that the helladothere was a gregarious animal, and lived in large herds or troops.

The same eminent paleontologist also describes the bones of a Ruminant larger than any living antelope, and placed, by virtue of its proportions, in an intermediate classification, between the antelope and the giraffe.

It is scarcely necessary to repeat that the hind-quarters of the giraffe are very much shorter than its fore, while the reverse prevails among the stags and most of the antelopes. Now, in the animal we are speaking of, both the fore and hind-limbs are of nearly the same length.

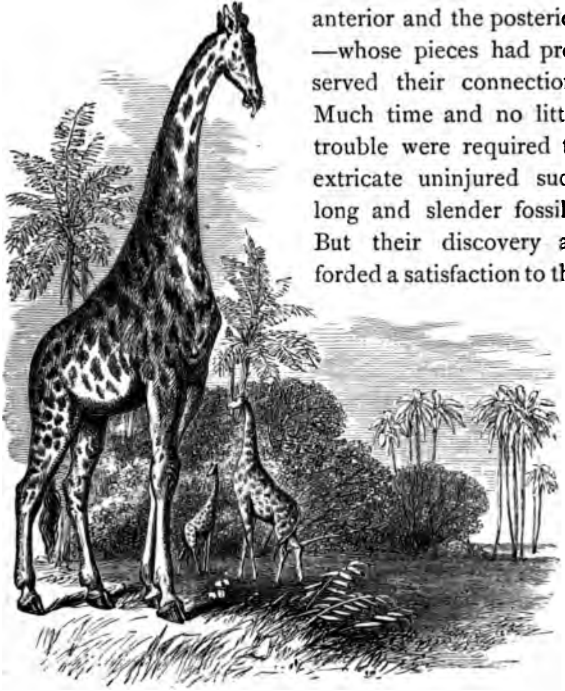
We are unable to determine, however, with any satisfactory degree of exactness, to what particular genus this animal should be referred.

VII. THE GIRAFFE.

Ancient Greece had its Giraffe.

Observe that the Tertiary strata of Europe, which enclose, as we shall shortly see, such numerous remains of Proboscidea and huge Pachydermata, had not furnished, before the researches at Pikermi, any relic of gigantic Ruminants.

During the summer of 1860, however, at a season when the mountain-torrent of Pikermi had sunk low enough to admit of excavations being undertaken in its channel, M. Gaudry discovered some large bones lying in a position perpendicular to the trench or cutting he had just opened. When they were brought into the light of day, they were found to consist of two nearly complete limbs of a giraffe — the anterior and the posterior —whose pieces had preserved their connection. Much time and no little trouble were required to extricate uninjured such long and slender fossils. But their discovery afforded a satisfaction to the paleontologist which more than compensated for any labour it entailed. For was it not strange to encounter in the narrow hill-country of Attica an animal akin in all respects to the giraffe which nowadays inhabits the vast plains of Africa !



THE GIRAFFE.

The giraffe of Attica, however, was larger than that of Senegal, and, especially, than that of Nubia. It must have closely resembled, in structure as in organization, the giraffe of the Cape.

But it must be noted that its bones are not so thick as in the living species. The articular extremities are narrower. Nor can this be due to any difference of age, for the fossil bones of Pikermi belonged to adult individuals.

We have already referred to the well-known characteristic of the giraffe—the great height of its fore, compared with that of its hind-quarters. In the fossil species the disproportion is less conspicuous than in the living.

Neither the head nor body has been found.

The slender form of its limbs affords some ground for the supposition that its neck was not so elongated as that of our modern giraffes, and that its skull was probably of inferior dimensions. But was this skull in every respect similar to that of the giraffe? We cannot pledge ourselves to an affirmative statement; for the Author of Nature has so varied the organization and structure of the fossil animals, that a Ruminant *may* have had the limbs, and even the neck, of a giraffe attached to a head of another form. But we are inclined to think that the primeval giraffe resembled, in all important particulars, the living camelopard.

CHAPTER VI.

THE PACHYDERMATA.

Innumerous living creatures, perfect forms,
Limbed and full grown.
MILTON.

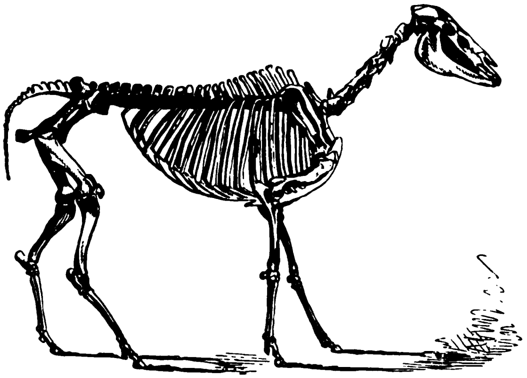
THE Pachyderms are chiefly remarkable for the thickness and hardness of their skin or hide. From this characteristic they derive their name (from παχὺς, *thick*, and δέρμα, *a skin*). They masticate their food, and do not ruminate, differing in this respect from the other hoofed Mammalia.

Cuvier divided the order into three sections: 1. *Proboscidea*, with an elongated snout or proboscis, which served as a powerful prehensile organ, and also as a subtly delicate organ of touch; 2. *Ordinaria*, destitute of proboscis, but with a prolonged upper lip and nostrils in many species approaching to it, and with four, three, or two toes on each foot; 3. *Solidungula*, animals whose foot has but one apparent toe, enclosed in a hoof. Some naturalists have added a fourth section, the *Herbivorous Cetacea*, as the manatee and dugong; others have separated the Solidungula (or Equidae, as the horse), and constituted them a distinct order. Cuvier's original arrangement is, however, the one most widely adopted.

THE HIPPARION.

Though allied to the modern horse, the *Hipparion* establishes a transition, or forms a link between two of the sections we have just described—that is, between the Ordinaria and the Solidungula.

It has a hoof like the Solidungula. True; but on each side of this hoof it has small toes, like the Ordinaria.



SKELETON OF THE HIPPARION.

Among the latter, it approximates most closely to a fossil Pachyderm, named the *Anchitherium*.

In other respects, while the conformation of the hipparion distinguishes it from the horse, it does not isolate it. Various points of transition are easily discernible.

And there are also points of transition, which are not less important, between the different *species* into which the genus *hipparion* has been divided.

The hipparion lived in numerous herds, like the wild horses of the Steppes, in the Tertiary plains of ancient Europe. Kaup and De Christol assert that it is found by thousands at Eppelsheim and in the Vaucluse. The quantity exhumed at Pikermi was "prodigious." Gaudry brought away nineteen hundred pieces, belonging to eighty individuals. These he attributes to a single species, with which he also identifies the hipparions of Vaucluse, Spain, Germany, India, though those of Vaucluse are characterized by slenderer bones than those of Greece, and those of Germany and India are larger.

The animal's skull is much smaller, compared with the height of its body, than is the case in our living Equidae. Otherwise, it possesses most of the characters of the latter. Wagner has pointed out a feature of peculiar interest—namely, a cavity which seems analogous to the eye-vein (*larmier*) of the stag and of several antelopes. Instead of being placed, as in the Ruminants, near the orbit, it is separated from it by the lachrymal gland. It is hollowed out of the maxillary, and, slightly, of the nasal bone; a canal passing under the lachrymal connects it with the orbit. Nothing like it exists in our living Equidae.

The teeth are identical in structure with those of the modern horse. Canines were found in all the jaws exhumed at Pikermi, whence we may conclude that the females habitually possessed them as well as the males, while in the mare they are very frequently deficient.

The molars are specially distinguished by more complicated designs of enamel, and by the circumstance that their interlobar column in the upper jaw is isolated in the cement; so that, when looked at on the triturating face, it gives by detrition an island, instead of a peninsula. Hence it results that the upper jaws somewhat remind the anatomist of those of Ruminants with great interlobar columns, as, for instance, the ox; and this explains why Roth and Wagner were induced to describe the molars of the hipparion under the name of the Marathon ox (*Bos Marathonius*).

The development of the teeth followed the same stages as in our living horse. The fore-teeth were first replaced; the canines appeared almost simultaneously with the intermediate of the second dentition; the wedge-shaped came afterwards. The two first back-molars were generally put forward before the fall of the milk-teeth. About the time that the second back-molars came forth, the two first milk-molars gave way to the pre-molars; some time after the third milk-molars were replaced, and the last back-molars shot up in the jaw. The lower milk-molars carry columns of ivory, which prevent them from being confounded with the living Equidae.

The vertebrae resemble those of the horse.

The single essential character of the hipparion's limbs is, that the parts of the feet are less reduced than in the other Equidae. The lateral metacarpians, though slender, are complete, and each is provided with a small toe composed of three joints; while in our living Equidae the second and third metacarpians in their lower part grow fine by degrees and beautifully less. A rudimentary bone, set at the external border, represents the fifth metacarpian : in general, no vestige of this piece is found in the horse. On the inner edge may be seen a very small bone,—which is, according to Hensel, the first metacarpian; according to Gaudry, the trapezium,—but which in every case establishes a difference from the horse, since the latter has neither. The hind-foot of the hipparion is also less reduced; the second and fourth metatarsi are complete, and each possesses a toe composed of three joints.

This information establishes, as we have already said, a transition between the Solidungula and the Ordinaria. Hensel has rendered this transition the more perceptible by citing five cases in which the living Equidae have presented the anomaly of two lateral toes analogous to those of the hipparion. All these bones, whose existence is normal in the hipparion, may be found teratologically in the horse; these fugitive reappearances may be regarded as a return to a type which has been extinct since the Tertiary epoch.

Let us now glance at some of the variations presented by the hipparions of Pikermi.

They separate them into two distinct species: in the one, the metacarpals and metatarsi are long and slender; in the other, the metacarpals and metatarsi are shorter but bigger. If the other bones observed the same proportions, in the first variety the limbs would be singularly feeble, and in the second as singularly large. But such is not the case. The elongation of the humeri, the radii, the femurs, and the tibias is proportionate to their thickness, so as to furnish a kind of compensation for the metacarpals and metatarsi. Thus, then, the thin-limbed and the stout-limbed species were probably almost equal in point of stature; the one being slightly larger than the zebra, and the other nearly of the same size.

These differences led Hensel to separate the hipparions into two species; and to the more ungainly or heavier one he has given the name of *Hipparion brachypes.* "It is founded on the principle that variations of age or sex cannot be the cause of unequal development of the bones, while the thicker metacarpals and metatarsi being also the shorter, we must suppose that they were shorter and thinner in males or the aged; which is opposed to the facts known of other animals." Hensel's observation is very just; but because the differences of proportion in the hipparions of Pikermi is due neither to sex nor age, it does not result that it possesses a *specific* value. If, in fact, we fix our eyes on the extreme forms, we find two very distinct groups; but if we set all the homologous bones in a series, we see so many intermediaries that we know not where to establish a line of demarcation.

The geologist Gaudry furnishes a proof of this in two tables; the first of which gives the measurements of the entire range of molars in twenty different jaws — and, second, the measurements of the bones of the limbs. These tables exhibit a gradual declension in the dimensions of all the bones which they comprise. They show also that the length of these bones increases with their thickness.

However great, then, he concludes, may be the variations of the hipparions of Pikermi, the intermediates between their extremes will induce the judicious paleontologist to refer them to a common stock. It has been well remarked that we must observe a great discretion in the reunion of the fossil Equidae, remembering that if we found several species of living Equidae imbedded in the earth's strata, we could not separate them. This is an important truth. The dauw, the quagga, the zebra, and even Equidae still further apart in their external characters, resemble each other from an osteological view-point : consequently, the naturalists who regard each of these animals as the representative of a particular species, would perhaps dignify as species our two varieties of hipparions, if they were acquainted with their skin, their voice, their habits. But we can reason only from the elements we have at our disposal. When a paleontologist assembles certain fossils under one inclusive term, he does not pretend absolutely that they belong to a single species: he means only that, so far as osteological data are concerned, he has no ground for separating them.

Beside the differences we have here indicated, some exist in the form of the molars. It is curious to see how changing are the characteristics of the dentition, though they furnish the best basis of specific or generic distinctions.

The small lower milk-molar which in the horse exists in front of the other molars, is wanting in all the lower jaws found at Pikermi: in the upper jaws it is generally met with, but its size varies from simple to triple.

While the variations in the second teething are less numerous than those in the first, yet they are also very striking. In one and the same jaw we see this or that molar whose ivory has formed a ridge at the antero-internal corner, or rises in the shape of a column, while the other molars present no peculiarity.

Much consideration is necessarily given to the degree of ridging of the enamel, because this is one of the characters by which the molars of the hipparions are distinguished. It varies not only in the species of the genus *horse*, as Professor Owen has demonstrated, but also in individuals of the same species of *hipparion*. If we were to arrange all the jaws of the hipparions of Greece side by side, we should detect an almost imperceptible passage from teeth with much-ridged ivory to teeth with scarcely ridged ivory; and in the same jaw great inequalities frequently occur in the ridging of the ivory of the molars.

From these observations Gaudry deduces some important consequences. If I am right, he says, in attributing to a single species all the hipparions of Pikermi, I am led to refer also to the same species the hipparions of the Vaucluse, Spain, Germany, and India, since some of their individuals, from what we know of them, perfectly resemble those of Pikermi. Yet I have remarked,—

1st, That generally the hipparions of the Vaucluse have smaller bones than those of Greece;

2nd, That often the hipparions of Germany were larger than those of Greece, and that the enamel of their molars was more plaited; and,

3rd, That the hipparions of India attained a maximum of stature to which those of Greece could never rise.

Hence we must infer that fossil animals sprung from the same origin present, according as they are found in France, Spain, Germany, or India, differences sufficiently conspicuous to justify paleontologists of deserved repute in assigning them a specific value.

We discover transitions not only between the species of the genus hipparion, but between this genus and the horse. On the one hand, the teratological observations of Gurlt, pointed out by Hensel, and those of Goubaux, prove that, so far as the form of the limbs is concerned, the distance or interval between these two genera may be easily passed; on the other, according to Rütimeyer, certain fossil horses are intermediary, so far as their dentition is concerned, between our hipparions and our living Equidae, having the enamel of their molars more plaited than in the latter, and their interlobar column smaller, better rounded, and less closely set against the base of the tooth.

Finally, we know that by their lateral toes the hipparions connect the ancient order of Solidungula with the *anchitherium* genera of the order of Pachydermata. It must, nevertheless, be admitted that if they approximate to the anchitherium in the form of their hoofs, they recede from it in their dentition; which, in spite of appearances, is akin to that of the Ruminants, and especially of certain Pachyderms with two toes. But when we reflect upon the rapidity with which so many other lacunae have been filled up by paleontological discoveries, we are justified in hoping that this one also will be supplied before any considerable time has elapsed.

CHAPTER VII.

THE PACHYDERMATA :—ORDINARY PACHYDERMS.

I. THE ERYMANTHIAN BOAR.

The tuskèd boar out of the wood
Up turns it by the roots.
MILTON, *Psalm* lxxx. 53.

ONE of the famous twelve labours which, according to the Greek poets, were accomplished by Heracles or Hercules, was the capture of the wild boar which had descended from Mount Erymanthus into Psophis, and there committed the most terrible ravages.

It is certain that a wild boar lived in Greece during the Tertiary epoch. To this wild boar, in allusion to the old myth, Roth and Wagner, who have recovered its jaws and one of its metatarsal bones, have given the name of *Sus Erymanthius.* Yet we must not conclude that the species exhumed among the fossil treasures of Pikermi resembled the Erymanthian boar of Greek fable. The effigy of the latter has been preserved on the bas-reliefs of the Temple of Jupiter at Olympia ; and Etienne Geoffroy Saint-Hilaire has reproduced it in his great work, "L'Expédition de Morée." A reference to his designs and descriptions will show that the skull of the mythological species is more triangular than that of our fossil boar, less elongated, and provided with stronger canine teeth.

M. Meunier, on whose book the present volume is partly founded, informs us that he has collected six skulls of the *Sus Erymanthius*, and a great number of other fragments; attesting the existence, in all, of twelve individuals—two young, and ten adults.

The incisors resemble those of other boars. All the upper or lower canines, so far as present observations go, are small. Must we, then, conclude that neither males nor females had any great tusks? Is it preferable to think that the females lived in herds, and that, in the researches hitherto made at Pikermi, only the remains of females have been met with? The first supposition will appear the least probable, if we consider in what feature the Grecian species is akin to the living boar. Yet it is singular that no tusks have been discovered; and Rütimeyer has made the remark that in the wild boars of the Tertiary strata the canines would appear to have been less developed than in present species.

The cranium is a third larger than that of the *Sus scropha* (our domestic pig): it is less contracted in the parietal region, and the upper side makes with the posterior a sharper angle.

The bones of the trunks and limbs offer the same details of configuration as those of living species; but their proportions are different. They are larger compared with their length, and show that their owners were of smaller size than from the dimension of their skulls we should have anticipated. The Erymanthian boar must have been a far more compact and massive beast than our living boars.

The contradictory opinions put forward on the subject of the *species* of fossil boars by the best naturalists afford yet another proof, says Gaudry, that isolated fragments, even of jaws, do not permit us to determine the species of a fossil Mammal. A great number of boars have succeeded one another from the Miocene epoch down to our own day; but as the majority are represented only by incomplete fragments, nothing can be obscurer than their history. We may say, however, to judge from the few elements already collected, that their dentition seems to hold an intermediate place between that of the *palaeocherus*, a genus of the Lower Miocene, and that of our present pig: the French sow (or *sus* of the Orléanais) would be an example. Further, their dentition occupies a middle position between that of the *sus scropha* and that of the *sanglier à masque:* the *sus provincialis* of the Pliocene stratum of Montpellier furnishes a proof. The Erymanthian boar may also be cited as an intermediate type; for if we consider, not only its teeth, but the aggregate of its characters, we shall find it difficult to say whether it is to the *sus scropha* or the *sanglier à masque* that it presents the greatest resemblance.

II. THE ANOPLOTHERIUM AND THE XIPHODON.

The *Anoplotherium* (from *ἄνοπλον*, *without a tusk*, and *θηρίον*, *a wild animal*), which Cuvier looked upon as connected with the rhinoceros, the horse, the hippopotamus, the pig, and the camel, is extremely abundant in the plaster quarries in the environs of Paris. Skeletons nearly perfect even have been exhumed; and, to the great delight of all paleontologists, the mould in plaster of this animal's brain—a brain deprived of circumvolutions—has been discovered.

It is by the restoration of this genus, and of that of the Palaeotheriums—of which we shall speak hereafter—that Cuvier has established the fact, previously suspected but not demonstrated, that races of animals formerly existed which have no representatives in living nature.

When he gave the amplotherium to science, he possessed but a few remains of it. The recovery of the parts which his sagacity divined quickly confirmed all his indications.

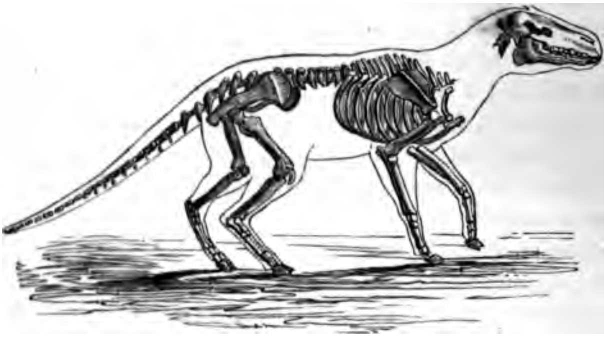
Every time, says Duvernoy, that Cuvier submitted a new memoir to the French Institute on some recent determination of these curious bones of another world, he was met by the incredulity of certain of his colleagues, who, unacquainted with the laws of organization and the necessary co-existence of certain forms, could not comprehend how it was possible to restore or rebuild an animal out of the fragments of bones scattered through the layers of the same soil. A few days after a sitting in which Cuvier had been more particularly assailed with this objection, he had the satisfaction of receiving an entire skeleton of the very animal he had created out of a few disconnected fossils, and was able to demonstrate in nature the being which Science had so skilfully rehabilitated.

This animal was no other than the anoplotherium.

Cuvier on this occasion (November 1806) wrote to Duvernoy:—

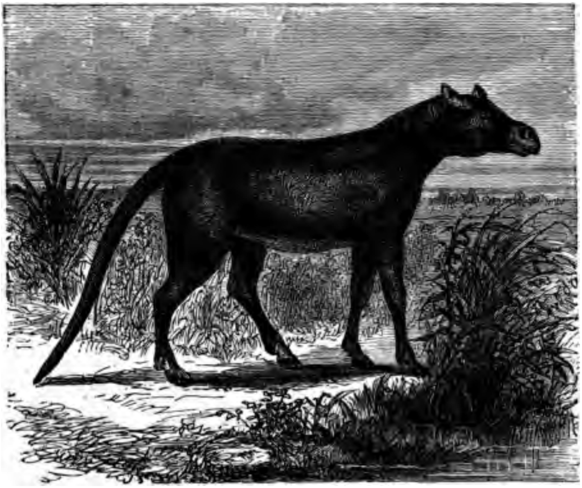
"A complete skeleton of the anoplotherium has just been brought to me from Montmartre. It is five feet long. All my conjectures are verified by it; and I learn, moreover, that the animal had a tail as long and as thick as the kangaroo, which completes its singularities."

The anoplotherium has two characteristics never observed in any other animal: feet with two toes, whose metacarpal and metatarsal bones remain distinct, and do not unite *in canons* like those of the Ruminants; and teeth in a continuous series, uninterrupted by any lacuna. Man alone has teeth thus closely set together, without a void. Those of the anoplotheriums consist of six incisors in each jaw, a canine and seven molars on each side, above and below; the canines short, and not unlike external incisors. The three first molars are com-



SKELETON OF THE ANOPLOTHERIUM.

pressed; the four others, in the upper jaw, are square, with transversal ridges, and a small cone between them; in the lower, they are marked with a double crescent, but without any adhesion (*collet*) at the base. The latter has three crescents. The head is of an oblong form, and gives no indication whether the snout terminated in a proboscis or like a wild boar's.



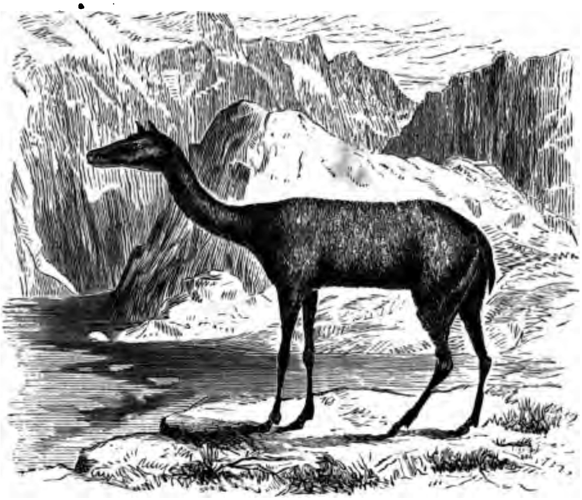
THE ANOPLOTHERIUM, RESTORED.

Cuvier divided the anoplotheria into three sub-genera: the *Anoplotherium* properly so called, the *Xiphodon*, and the *Dichobuné*. To these has been added the *Microtherium*.

Among the species belonging to the first group, the one most frequently found in the gypsum strata of the

Upper Eocene, has been called the common anoplotherium. Its height to the withers was considerable, reaching, if not exceeding, three feet and some inches; but it was chiefly distinguished by its enormous tail, which gave it somewhat the appearance of an otter; and it is very probable that it was useful as a support, like that animal's, upon and in the water, especially in marshy localities. But it did not frequent them for the sake of fishing. Our anoplotherium was not less herbivorous than Nebuchadnezzar; and if it resorted to the pool and swamp, resorted thither to feed on the roots and succulent stems of aquatic plants. From its habit of swimming and diving, its hair must have been smooth as an otter's; perhaps its skin was half-naked. It could not have had long ears, for these would have impeded its progress in the water; and, in this respect, we are inclined to believe that it resembled the hippopotamus and other semi-aquatic animals. Its total length, tail included, must have been eight feet, and without the tail five feet and a few inches. The length of its body was therefore nearly the same as in an ass of moderate size, but its stature was not quite so considerable.

The *Xiphodon gracile*, of the size of a chamois, was as slender and graceful as the prettiest gazelle. It was not embarrassed in its rapid course by a long tail; but, like all the agile Herbivora, it was probably a timid animal, whose large mobile ears, like those of the stag, warned it of the slightest danger. There can be no doubt that its body was covered with a smooth hair; and that, consequently, we need only to know its colour to paint it in its habit as it lived—as it formerly enlivened the region



THE XIPHODON, RESTORED.

where, after so many centuries, its few remains have been disinterred.

III. THE PALAEOTHERIUM AND THE LOPHIODON.

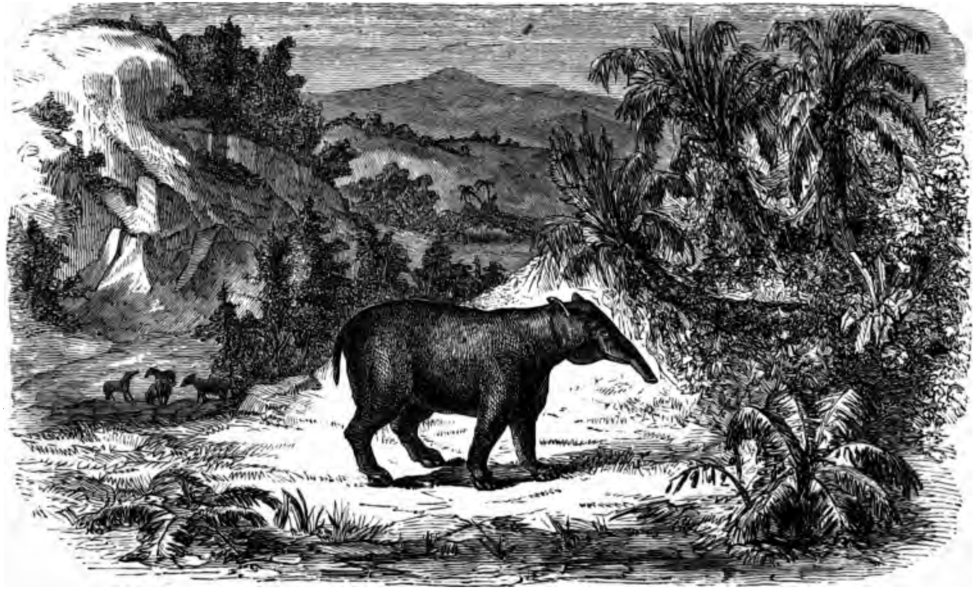
It is not difficult to put before our mind's eye a picture of the *Palaeotherium* (from παλαιόν, *old*, and θηρίον, *wild animal*). Its body was short, thick, and ungainly; it had short but very robust legs; the feet were supported by three toes inclosed in a hoof; the head was immensely large, with a nose terminating in a muscular fleshy trunk, or rather snout, like a tapir's; eyes small, dull, and displaying little intelligence; the general size, that of a large horse. Its remains have been found in such quantities as to show that it must have lived in great herds, in the valleys around the Paris basin, the lacustrine districts of Orleans and Argenton, the Tertiary formations of Rome, and the limestone plains of the Isle of Wight.

In each jaw it had six incisors and two canine teeth; its molar teeth resembled those of the rhinoceros: the upper were square, with projecting ridges of diverse configuration; the lower, shaped like double crescents. Their feet were divided into three toes; in the tapirs, the two fore-feet have four.

The geological place of this great Pachyderm seems to have been the first great fresh-water formation of the Eocene period, where it is chiefly found with its allies, of whom Cuvier discovered and identified about fifty species. Dr. Buckland, and other geologists, are of opinion that it flourished on the banks of the lakes and rivers, in the same manner as our modern tapir and rhinoceros.

The palaeotheria differed greatly in size: while some were as large as the rhinoceros, others were no larger than a roe, a hog, or a horse. One species, the *Palaeotherium minimum*, was about the magnitude of a hare, and not less active and nimble. It lived upon fruits, seeds, green twigs, and juicy aquatic plants.

The *Lophiodon*, which varied in size from that of the rabbit to that of the palaeotherium, was more closely allied to the tapir than to the latter. Its lower molars have transverse ridges, like those of the tapirs. From these, however, they differ, because its premolars are more simple; the last of all has three ridges, and the upper are rhomboidal in front, and very like those of a rhinoceros.



PALAEOTHERIUM.

" The general size of the palaeotherium was that of a large horse."

IV. THE LEPTODON.

This is a genus closely allied to the palaeotherium, and was founded by Gaudry on the data furnished by a couple of jaws discovered at Pikermi. The name of *Leptodon* (from λεπτός, *thin*, and ὀδούς, *a tooth*) refers to the slender form of its molars, which are of the same size, and have much the appearance of those of the *Palaeotherium medium*. But the elongation of the first premolar, its division into two crescents, and the circumstance that next to it, apparently, was placed the canine, establish important differences.

If the leptodon, as Gaudry supposes, were a Rhinoceroid, with its teeth in a continuous series, it would serve to fill up the hiatus at present existing between the striped and the unstriped Pachyderms.

V. THE ANTHRACOTHERIUM.

The genus of *Anthracotherium* is nearly intermediate, says Cuvier, between the palaeotherium, the anoplotherium, and the hog. The palaeothere it resembled in the molars of its lower jaw, the anoplothere in its upper molars, and the hog in the fact of its lower incisors being set forward. Add to this that its canines resembled those of a rabbit. Several species have been identified, the largest approaching the rhinoceros in size.

VI. THE PALOPLOTHERIUM.

Cuvier describes seven species of palaeotheria, and since his time other species have been determined; but one of these, which the great naturalist named *Palaeo-*

therium minus, is now included in the allied genus of the *Paloplotherium.*

One new species of paloplothere was recently discovered in the limestone strata of Jumencourt, near Coucy, in the French department of the Aisne, and its remains consist of a skull almost entire, several jaws, the upper part of a cubitus, a tibia, an astragalus, and fragments of the pelvis and omoplate.

Previously this animal had not been met with so low down in the series of geological formations, and while the remains thus fortunately discovered have enabled Gaudry to establish a new species, the *Paloplotherium Codiciense* (that is, of Coucy), some peculiarities which they exhibit have led to remarks of the highest interest on the variations undergone by the dentition of the paloplothere in the course of ages, and on the passages established by these variations between the new genus and that of the palaeotheria.

Thus, while in two species of the latter the number of upper premolars is three, it is four in another species. While the last upper premolar has in one species four roots, in two others it has but three. While in one species the last upper premolar has two lobes, it has three in three other species.

Now I would call the attention of the reader specially to this fact: the transformation of the most important character of the dentition accorded apparently with the changes of the geological age.

Thus, the new species of paloplothere, which, as we have hinted, is the most ancient, having been discovered in the upper sub-formation of the Paris limestone, is the one which shows the most important differences in its dentition from the palaeothere.

Next to it comes a species, *Paloplotherium annectens*, found in the lower beds of the Hordwell, and less removed from the palaeothere.

Later still, and in the gypsum epoch, a third species appeared, *Paloplotherium minus*, which is so closely allied to the palaeothere that Cuvier could perceive no distinction; and simultaneously appeared the palaeotheres properly so called.

Finally, in continuing our chronicle from age to age, and approaching nearer and nearer to the pre-historic epoch, we find the palaeotheria themselves subjected in their turn, as Gaudry remarks, to the common law which swiftly carries the superior animals towards the period of extinction or transformation: we see them, after replacing the paloplotheria at the end of the Eocene epoch (in lower Tertiary strata), replaced in their turn early in the Miocene epoch (middle Tertiary strata) by the acerotheria.

In addition to the paloplotheria, five fossil genera seem to have been allied to the palaeotheria; and each comparative study of fossil beings, we may add, reveals new features of union existing among them.

VII. THE ACEROTHERIUM.

The *Acerotherium* is one of the most remarkable types discovered by paleontology, and, to some extent, supplies the gap between the rhinoceros and the other pachyderms. Hermann de Mayer remarked, in 1834, that in the conformation of its nasal bones, and in the folds of ivory on its lower molars, the acerotherium more resembles the palaeothere than the *Rhinoceros Schleiermacheri;* Gaudry adds that, in the robustness of its limbs, and its fore-feet with their four toes, it is also distinguished from the rhinoceros, and brought nearer to several other pachyderms. Only the lower jaw of this animal was found at Pikermi.

VIII. THE RHINOCEROS PACHYGNATUS.

A peculiar interest attaches to this species, inasmuch as it establishes the transition between two living African species, the *Rhinoceros bicornis* and the *Rhinoceros camus.*

In his earlier investigations Gaudry possessed only the skull of the animal, which in every respect was identical with that of the rhinoceros bicornis. Less experienced then than in after years, the eminent paleontologist formed the hasty conclusion that both the extinct and the living animal belonged to the same species. But remembering, he writes, the Ape of Greece, which has the limbs of a macacus and the head of a semnopithecus, and numerous other fossils presenting a similar association of characters, I thought that in the limbs themselves some differences might occur.

The examination of portions of these limbs fully justified both the caution and foresight of the great naturalist, and proved that the rhinoceros of Pikermi differs in many respects from the rhinoceros bicornis to approximate to the other African species, the rhinoceros camus; it has the head of the latter, the limbs of the former; in fact, it is a link between the two.

And thus, like the apes, like the Carnaria and Proboscidea found at Pikermi, the *Rhinoceros pachygnathus* (*i.e.*, "thick-jawed") establishes a transition between animals formerly regarded as distinct.

Where, inquires Gaudry, will paleontology stop in its discovery of these intermediary forms? No one can say; but for a distinguished paleontologist to put such a question shows very clearly the great change that has taken place in the opinions of geologists and naturalists since the days of Cuvier.

It is unnecessary to dwell upon the structure and organization of so familiar an animal. But we may observe that the teeth of the pachygnatus resemble those of the rhinoceros camus, which lives upon grasses and herbage, and of the rhinoceros bicornis, which feeds upon the young branches, and even on coriaceous shrubs.

So common had the rhinoceros become in the later geological ages, that Gaudry has collected upwards of seven hundred fragments of this animal, belonging to two and twenty individuals. So that in the comparison which he has established between the extinct and the living species, he was in no want of specimens of the fórmer, but of the latter. The Museum at Paris owns but a solitary skeleton of each of the two African rhinoceroses.

IX. THE RHINOCEROS TICHORHINUS, OR TICHORHINE TWO-HORNED RHINOCEROS.

The first notice and figure of fossil remains referable to the genus *Rhinoceros*, occurs, says Professor Owen,* in a quaint and extremely rare old tract, entitled, "Chartham News; or, A Brief Relation of some strange

---

* Owen, "British Fossil Mammals and Birds," pp. 325-328.

Bones there lately digged up in some grounds of Mr. John Somner of Canterbury" (London, 1669).

"News from Chartham in Kent. Although it may, and perhaps must be granted, that miracles (strictly understood) are long since ceased; yet in the latitude of the notion, comprehending all things uncouth and strange (*miranda*, as well as *miracula;* wonders as well as miracles), they are not so; but do, more or less, somewhere or other, dayly exert and show themselves, *dies diem docet.*" After some irrelevant matter, the writer, one Mr. William Somner, proceeds to the "matter-of-fact."

Mr. John Somner, he says, in the month of September, 1668, sinking a well at a new house of his in Chartham, a village about three miles from Canterbury, towards Ashford, on a shelving ground or bankside, within twelve rods of the river, running from thence to Canterbury and to Sandwich Haven; and, digging for that purpose about seventeen feet deep, through gravelly and chalky ground, and two feet into the springs, there met with, took, and turned up a parcel of strange and monstrous bones, some whole, some broken, together with four teeth, perfect and sound, but in a manner petrified and turned into stone, weighing (each tooth) something above half a pound, and almost as big, some of them, as a man's fist.

Alluding to the notices of the remains of giants then so common in the philosophical works of the time, Mr. Somner remarks that "so we must have judged of these teeth and of the body to which they belonged, had not other bones been found with them which could not be man's bones. Some that have seen them," he continues, "by the teeth and some other circumstances, are of opinion that they are the bones of an hippopotamus, or *Equus fluvialis*—that is, a river-horse; for a sea-horse, as commonly understood and exhibited, is a fictitious thing. Yet Pliny makes hippopotamum ('mari, terrae, amni communem') to belong to sea, land, and rivers. But what are the differences and properties of each kind I leave others to inquire. The earth or mould about them, and in which they all lay, *being like a sea-earth or fulling earth*, has not a stone in it unless you dig three feet deeper, and then it rises a perfect gravel."

The earth or mould to which our author refers, is the Post-Pliocene brick-earth and drift which, in Kent, Surrey, and Essex, have since yielded so rich a harvest of the remains of great extinct Pachyderms.

"So have you the story," continues Somner, "an account, if you please, of what was found, where, when, and upon what occasion. For more public satisfaction, and to facilitate the discovery; at least, to help such as are minded to employ their skill in guessing and judging of the creature, whose remains these are, what it was for kind; we have by and with the help of an able limner, adventured on a scheme or figure of several of the teeth and bones, with their respective dimensions of breadth, length, and thickness.

"No man, we conceive, not willing to be censured of rashness, will be very forward to divine, much less to define or determine what the creature was; and, doubtless, dubious enough it is whether of the twain, the sea or the land, may more rightly lay claim unto it."

Mr. Somner, however, after having taken "a large time of consideration of all particulars and circumstances fit to be duly and deliberately weighed and observed in the case," comes to the conclusion that it was some "sea-bred creature," and then proceeds to discuss, at length, the knotty point, "how it possibly came there, *piscis in arido* (a fish on dry land)?" The discussion divides itself into four branches:—

SKULL OF THE TICHORHINE RHINOCEROS.

"1. Whether the situation and condition, face and figure of the place, may possibly admit of the sea's once insinuating itself thither?

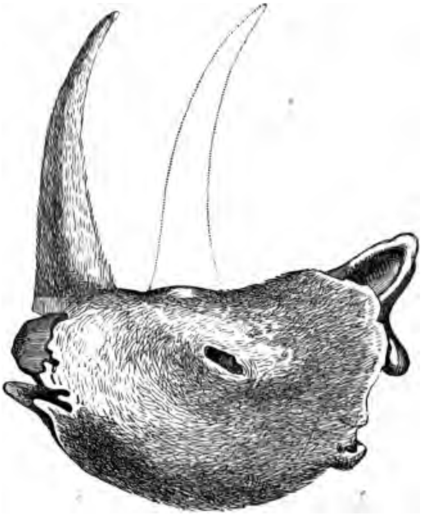
"2. Whether (that possibility being granted or evinced) the sea did ever actually insinuate itself so far as to this place, and when?

"3. How, in probability, and when, this valley or level being once sea-land, should come to be so quite deserted and forsaken of the sea, as it is at this day, the sea not approaching by so many, a dozen, miles or more?

"4. By what means the sea, once having its play there, this creature comes to lodge and be found so deep in the ground, and under such a shelving bank?" *

To these questions, however, it is unnecessary to furnish any answer. From the figure given of the remains of the supposed "sea-bred creature," our comparative anatomists are able to determine that it was not of marine, but of terrestrial origin, and that it was, in fact, no other than the *Rhinoceros tichorhinus.*

The tichorhine rhinoceros belonged to the Tertiary epoch, and owes its specific name to the bony partition between its nostrils, which does not occur in the living species. Its nose is surmounted by two horns. This arrangement exists in the rhinoceros of Africa and Sumatra, but the horns are smaller. Its body was clothed in thick shaggy hair, and its skin, tough and leathery, was free from the



HORNS AND HEAD OF THE TICHORHINE RHINOCEROS.

---

* This pamphlet is reprinted in the "Philosophical Transactions for 1701," No. cclxxii., p. 882.

scales which distinguish the hide of the existing African species.

Its gigantic horns, and the peculiar curvature of its nasal bone, seem to have originated many of our popular myths. Thus, the celebrated monster-bird, the roc, which figures in the story of "Sindbad the Sailor," may possibly have been suggested by the discovery of the cranium and horns of a fossil rhinoceros.

It is recorded that in Klagenfurt, a small town in Carinthia, a neighbouring cavern was formerly the retreat of a gigantic dragon which devastated the whole country. A gallant knight who ventured to attack it, killed it, but died of the wounds he received in the fierce affray. Do you doubt the story? Go to Klagenfurt, and you will find a proof of its veracity in the dragon's head, preserved in the old town-house, and in its stone model carved on the fountain in the principal street. Herr Unger, of Vienna, having accidentally heard the story, repaired, as we advise the reader to repair, to Klagenfurt, and saw the head. But then it proved to be the head of no gigantic dragon, but of a tichorhine rhinoceros.

A remarkable discovery of an animal of this species, with all its flesh and bones entire, was made in Siberia, towards the close of the eighteenth century. It was not found "alone in its glory," but associated with the remains of other animals in the same condition. All the circumstances connected with this interesting incident are narrated by the geographer Pallas, in his "Voyages dans l'Asie Septentrionale," and in a "Mémoire sur Quelques Animaux de la Sibérie," which he communicated to the

"Imperial Academy of Sciences" at St. Petersburgh. The following particulars are gathered from both sources :—

Early in December 1771, some Yakoutzki were hunting in the neighbourhood of Viloui, near the confluence of the river of that name with the Lena. Under a scarped rock, at no great distance above Zimovié de Vilouiskoe, half-buried in sand and water, they came upon the carcass of an enormous animal, unknown in that country. They took its dimensions on the spot; three and three-quarters Russian ells (equal to about eleven and a half English feet) in length, and three and a half ells in height, not including the feet and head. The body was already in an advanced state of decomposition.

The discovery made some noise, and the report of it reaching M. Adam de Bril, the governor of Irkutsk and Eastern Siberia, he ordered the head and two of the feet to be sent to him. Another foot was sent to the prefecture of Irkutsk; the remainder rotted on the spot where it was found.

In the month of March, 1772, Pallas arrived at Irkutsk; the relics of the unknown animal were shown to him, and he immediately recognized them as belonging to the rhinoceros.

The head, he writes, was specially recognizable, because it was covered by its skin, which had preserved all its exterior organization, and retained numerous short hairs. The eyelids and eyelashes even had not fallen entirely into decay. I saw a substance in the cavity of the skull; and here and there beneath the skin was the residuum of the putrified flesh. I remarked on the feet the very obvious remains of the tendons and cartilages, where the skin was wanting. The head had lost its horn, and the feet their hoofs. The situation of the horn, the fold of integument which surrounded it, and the separation existing in the fore-feet and hind-feet are certain proofs of the animal being a rhinoceros.

The governor of Irkutsk made him a present of the relics. As they exhaled a fetid odour, Pallas, before quitting Irkutsk, caused them to be dried in a furnace. The operation having been too carelessly performed, one of the hoofs was burned; the other, as well as the head, remained intact, and no wise damaged by desiccation, and are represented in his work.

The rhinoceros to which these limbs belonged was neither, he says, one of the largest of his species, nor far advanced in years. Yet he was evidently an adult. The entire length of the head, from above the nape of the neck to the extremity of the denuded bony jaw, was two feet three inches and a half. Evident vestiges could still be seen of the two nasal and frontal horns.

The skin which covered the greater part of the head appeared, in its dried condition, to be a tenacious and fibrous substance, like the leather which the currier prepares for sandals. Outside, its colour was a blackish-brown; inside, it was whitish; when placed in the fire, it smelt like common leather. The mouth, where the soft and fleshy lips should have been, was corrupted and lacerated; the extremities of the maxillary bone were bare. On the left side, which had probably been exposed for a longer period to the air, the skin was in some places putrified, as it were, and all corroded on the surface. The greater part of the mouth, nevertheless—and especially on the right side—was so well preserved over the whole surface, that over the whole extent, and even in front, around the orbits, could be distinguished the pores, or, more correctly speaking, the tiny orifices in which, undoubtedly, the hairs were implanted. In several places on the right side of the jaw numerous tufts of hair remained; most of them worn to the root, but some of them still two or three lines in length. They were stiff as bristles, and all of a cinereous colour, except one or two in each tuft which were quite black and much stiffer than the others.

What seemed most astonishing was, that the skin which covered the orbits and formed the eyelids, though these were deformed and scarcely penetrable to the finger—the skin which surrounded the orbits, though dried up, was gathered in circular folds. The cavity of the eyes was filled with a substance either clayey, or animal, like that which still occupied a part of the cavity of the skull. Under the skin the fibres and tendons were extant, and especially the remains of the temporal muscles; and, finally, great bundles of muscular fibres were pendent in the throat.

The foot which was preserved, and which, in all probability, formed the hind part of the left leg, retained not only its hairy skin, and the tendons and ligaments of the heel in all their strength, but also that very skin in its entirety up to the bend of the knee. The place of the muscles was filled with a black mud. The extremity of the foot was split into three angles, whose osseous parts existed along the perioseum. The hairs also adhered to many parts of the skin of the legs, from one to three inches long, of a dirty cinereous colour.

How did the rhinoceros, an animal now found only in the Tropical regions, contrive to exist in the cold Arctic climes?

On this point, we shall quote the judicious observations of one of the greatest of living paleontologists, Professor Owen.

Although, he says,* the molar teeth of the rhinoceros tichorhinus present a specific modification of structure, it is not such as to support the inference that it could have better dispensed with succulent vegetable food than its existing congeners; and we must suppose, therefore, that the well-clothed individuals who might extend their wanderings northwards during a brief but hot Siberian summer, would be compelled to migrate southward to obtain their subsistence during winter. Plants might then have existed with longer periods of foliation than those which now grow. This, at least, is a less extreme hypothesis than the sudden change from a Tropical to an Arctic climate, which has been proposed to account for the preservation in ice of entire elephants and rhinoceroses; and Dr. Darwin has well remarked that "as there is evidence of physical changes, and as the animals have become extinct, so may we suppose that the species of plants have likewise been changed." But admitting the more probable necessity of migration, we may derive some insight into the habits of the Siberian rhinoceros by inquiring into those of existing large Herbivora of Arctic climes, which were represented by species coeval with those extinct rhinoceroses. Now, the musk ox is remarkable at the present day for its geographical position in high northern latitudes, and its adaptation to such by its peculiarly fine woolly clothing, and its periodical migrations have been noticed by experienced naturalists. The appearance of the musk ox in the month of May on Melville Island, in latitude 75°, was one of the phenomena ascertained in Captain Parry's first voyage, and "is interesting," Dr. Richardson observes, "not merely as part of their natural history, but as giving us reason to infer that a chain of islands lies between Melville Island and Cape Lyon, or that Wollaston and Banks Lands form one large island, over which the migrations of the animals must have been performed."

---

* Professor Owen, "British Fossil Mammals," pp. 353, 354.

CHAPTER VIII.

THE PACHYDERMATA :—THE PROBOSCIDEA.

I. THE MASTODON.

IN the Middle, or Miocene Tertiary epoch, the Pachyderms were still the prevailing forms; and among these, not the least interesting was that huge quadrupedal mammal, the Mastodon.

Hugh Miller describes it with his usual graphic force. In height, he says,* it did not surpass the African elephant, but it considerably exceeded it in length—a specimen which would not have stood above twelve feet high, indicating a length of about twenty-five feet; it had, what the elephants want, tusks fixed in its lower jaw, which the males retained through life, but the females lost when young; its limbs were proportionally shorter, but more massive, and its abdomen more elongated and slim; its grinder teeth, too, some of which have been known to weigh from seventeen to twenty pounds, had their cusps elevated into great mammal-like protuberances, to which the creature owes its name,* and wholly differ in their proportions and outline from the grinders of the elephant.

---

* Hugh Miller, "Testimony of the Rocks," pp. 89, 90.

From the form of its teeth it was at first supposed to have been a Carnivore, and Hunter named it the "carnivorous elephant;" but it is now known that its habits were herbivorous.

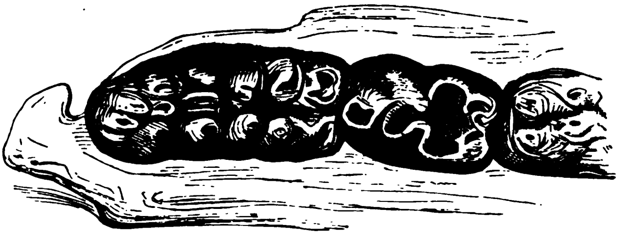
Cuvier describes two species: the *Mastodon angustidens*, or "narrow-toothed mastodon;" and the *Mastodon magnum*, or "great mastodon."

The former abounded in Europe, in the Val d'Arno, and in America in the Cordilleras. Near Santa Fé de Bogota is the "Field of giants," so called on account of the numerous bones of mastodons embedded there, which were formerly taken for human remains. And in like manner, the great quantity of relics of this animal found in the Cordilleras originated the Spanish traditions of men of a colossal stature who formerly inhabited Peru.

The great mastodon, a larger species than the foregoing, and in proportion as high as the elephant, had tusks not less enormous, projecting from the upper jaw, with an equally remarkable proboscidal development. Its bones are scattered in immense numbers over the American continent, and even entire skeletons have been frequently found. Their colossal dimensions and their abundance have naturally impressed the imagination of the Indians. The Chavanais pretend that men of a stature fitting them to cope with the mastodon lived at the same epoch. The Indians of Canada and Louisiana call it the "Father of the oxen," and assert that a troop of these tremendous quadrupeds made fearful havoc for some time among the deer, the buffaloes, and all the other animals created for the use of the Indians, spreading desolation far and wide. At last, they say, the "Mighty Man Above" seized his thunderbolt and slew them all, with the exception of the largest of the whole, who, presenting his head to the thunderbolts, shook them off as they fell; but, being wounded in the side, he betook himself to flight towards the great lakes, where he still resides at the present day.

---

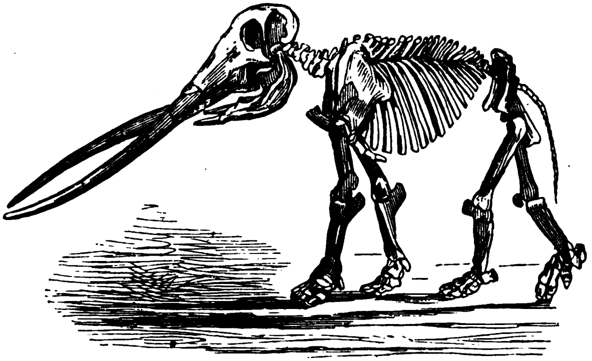
* That is, from μαστός, *a teat*, and ὀδούς, *a tooth*.



TEETH OF THE MASTODON.

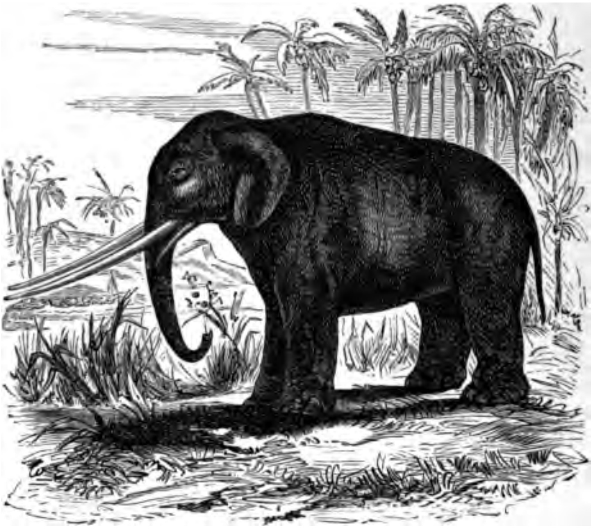
An Indian song runs thus:—When the great Manitou descended to the earth in order to satisfy himself of the happiness of the creatures he had called into existence, he interrogated every animal in turn. The bison replied that he would be fully content with his lot in the rich green leas, were he not compelled to keep his eyes constantly turned towards the mountains, and watch for the approach of the Father of Oxen, as he descended, in his rage, to devour him and his companions.

The bones of the mastodon are frequently, most frequently, found in marshy localities, at a very moderate depth—some three to five feet; and as they are always in perfect preservation, and not rolled, it is evident the animal must have perished on the spot where its remains are discovered. Sometimes the skeletons are vertically placed, as if the mastodons died standing, and sinking amid mud and mire. The most plentiful harvest is gathered in the basin of the Ohio; whence the names given to the mastodon in the last century, of "great animal of the Ohio," "elephant of the Ohio," and "mammoth of the Ohio."



SKELETON OF THE MASTODON.

One of these deposits lies in the State of Kentucky, four miles to the south-east of the Ohio, and nearly opposite the river Grande Miame. It is a marsh situated between two hills, and known as the "Great Bone Lick." Here the mastodons are embedded nearly five feet deep in black mud, along with the remains of other animals. It was here that President Jefferson collected the bones—a tusk, two half-jaws, a tibia, a radius, a tarsus and metatarsus, phalanges, ribs, vertebrae—which he sent to Cuvier, and from which the great naturalist restored the mastodon.



THE MASTODON, RESTORED.

Mr. Collinson, a Fellow of the Royal Society of London, and the friend and correspondent of Franklin, supplying Buffon with an account of some bone discoveries made by Croghan in 1765 on the river Ohio, wrote:—

"At about a mile and a half from the river lay six immense skeletons, interred upright, and carrying tusks of from five to six feet in length, which in form and substance were identical with those of elephants. At the root they measured thirty inches in circumference; they gradually narrowed towards the tip; but we cannot well determine how they were attached to the jaw, because they were broken in pieces. A femoral bone of these animals was also found entire; it weighed one hundred pounds, and was four feet and a quarter long. These tusks and thigh-bones prove that the animal was of a prodigious size. These facts have been confirmed by Mr. Greenwood, who saw six skeletons in the salt marsh. In the same place, moreover, he found some large teeth, which did not appear to belong to the elephant, but rather to the hippopotamus; these he has sent to London, including two which weighed together nine pounds and a quarter. He says that the jaw-bone was nearly three feet long, and too heavy to be carried even by two men. The interval between the orbit of the two eyes measured eighteen inches. An Englishwoman, taken prisoner by the savages, and led to this salt marsh to learn the process of making salt by evaporation, declared that she remembered, through a singular circumstance, to have seen these enormous bones. Three Frenchmen, she said, cracking nuts, were all seated on one of these gigantic thigh-bones."

In another bone-cemetery, likewise situated in the county of Ohio, and in Wythe county, Virginia, Bishop Madison, according to Cuvier, discovered in 1805, at a depth of six feet, and on a bed of limestone, a great number of bones. What rendered this discovery unique was, that in the middle of the bones lay a partly masticated ball of small twigs, grasses, and leaves, among which was recognized a kind of reed still common in

Virginia, and that the whole appeared to be enveloped in a kind of sac, which we may suppose to have been the animal's stomach ; so that it cannot be doubted that these were the half-digested substances forming its usual food.

Professor Barton relates that one of these animals still preserved its trunk ; and Klein says that in a skeleton exhumed in Illinois, the fleshy portions of the mouth were still in tolerable condition. This preservation may be explained by the saline nature of the soil, while it proves that the destruction of the great mastodons is comparatively recent.

The first notice of them in modern times refers to the narrow-toothed mastodon. Some of its bones were discovered, in 1613, in a sand-pit near the castle of Chaumont, in Dauphiné ; and Mazuya, a surgeon, who purchased them, pretended that he had come upon them in a brick tomb, thirty feet by fifteen, inscribed with the name of *Teutobocchus Rex*—a chief of the Cimbri, defeated near Aquae Sextiae by the Roman commander, Marius. In 1832 the skeleton was handed over to the Museum of Natural History in Paris, where De Blainville recognized it to be a mastodon.

In 1712 Dr. Mather informed the learned Wollaston that some gigantic bones had been discovered, seven years before, at Albany, in the State of New York, near the river Hudson. These, of course, were bones of the mastodon, but their identity was not detected, and they were accepted as additional proofs of the ancient stories relative to the past existence of a race of giants.

In 1739, M. de Longueil, a French officer, while navigating the river Ohio, found a "treasure-trove" of bones, teeth, and tusks on the borders of a morass. They were sent to Paris; and it is worth notice that these were the first relics of the great mastodon which had been seen in Europe. They now form a part of the collection in the Museum of Paris. The animal to which they belonged received at the outset the appellation of "the great animal of the Ohio."

Daubenton recognized the thigh-bone and tusk as the thigh-bone and tusk of an elephant, but the teeth he attributed to an hippopotamus. Buffon refused to accept this diagnosis, asserting that both teeth and tusks belonged to one and the same animal, an animal whose species had disappeared from off the face of the earth, as the ammonites had disappeared from the depths of the sea.

It is impossible not to believe, he said, that, independently of the elephant and the hippopotamus, whose remains we meet with in the two continents, there existed another animal, common to both, of dimensions far surpassing those of the largest elephants; for the square form of its enormous molar teeth prove that they were numerously implanted in the creature's jaw; and if we suppose that no more than six or even four were ranged on either side, we may still conceive how enormous must have been the head, each of whose sixteen or twenty-four molar teeth weighed ten or eleven pounds.

But Buffon was here in error. He supposed that all the teeth of the mastodon, instead of springing up in succession, armed its formidable jaws in a continuous row. Such is not the case with any of the Proboscidea. Take, for instance, the elephant. The molar which it employs in mastication is so placed that it wears out, and diminishes, not only in thickness but in length. While the animal is making use of it, another is developed. The latter pushes before it the active tooth, in the direction of the length of the jaw, over which it glides; and the root, shaken by this singular mode of locomotion, is broken, decomposed, and diminishes in size in the same proportions as the entire tooth. In due time the tooth itself gives way, and eventually yields its place to the new molar, which has so long been operating against it. Another germ is developed behind this second tooth, and pushes it in its turn until it is worn out and got rid of.

The teeth of the mastodon were subject to the same law of growth and decay. As Cuvier tells us, it is certain that the great mastodon had successively at least four molars on either side of the lower jaw; and as there is no reason for supposing that the upper jaw was less efficiently supplied, we may conclude that it possessed sixteen in all, only never sixteen at any one time. As in the elephant, their order of succession was from front to back. When the back tooth began to pierce the gum, the front was worn out, and ready to fall; and thus, "an Amurath an Amurath succeeds." It does not appear that more than two were ever in full operation on the same side; at the last there would be but one, as in the elephant. But Cuvier, in *his* turn, is wrong—wrong as to the number of teeth which one huge

Proboscidean enjoyed successively. This number was not sixteen, but *twenty-four;* that is, six on each side of either jaw.

We may add that, since Cuvier's time, it has been discovered that several species of mastodon had no teeth in vertical replacement.

According to the great French naturalist—the founder of Paleontology*—the great mastodon was not superior to the elephant in height. Moreover, it resembled it closely in its tusks and its entire osteology—the jaws excepted, which were somewhat more elongated. Its limbs were more massive, its abdomen slenderer. Its food was nearly the same as that of the hippopotamus and wild boar: it chose, in preference, the roots and other succulent portions of plants, a partiality which attracted it towards damp and marshy localities. It was not able, like the "river-horse," to swim, and live a long time in the water; but was, essentially and decidedly, a terrestrial animal.

Several new species of mastodons have been established since the researches of Cuvier; and our eminent Anglo-Indian paleontologists, Falconer and Cautley, have proposed their division into two sub-genera. They would designate as *Trilophodons* (τρίλοφος, *three ridges;* and ὀδούς, *a tooth*) the species which have three ridges on the third milk-molar, the first and second molar of the second dentition, and which have two ridges on the second milk-molar. And they would name *Tetralophodons*

---

* Cuvier, "Le Régne Animal."

(τετράλοφος, *four ridges*) the species in which the third milk-molar, and the first and second molar of the second dentition, are characterized by four ridges, and the second milk-molar by three.

But Gaudry has discovered in Greece the remains of a species intermediate between these two sub-genera—the *Mastodon Pentelici.*

Like the tetralophodons, its second molar tooth is marked by three ridges.

And, like the trilophodons, it has four ridges on its third milk-molar.

Some naturalists, says Gaudry, have already suggested that the head of the mastodon must have been longer but lower than that of the elephant, and, in this respect, must have approached nearer to the ordinary type of Pachyderms. Their suggestion is confirmed by an examination of the head of the mastodon Pentelici. When it wished to touch the earth with its trunk, it must have been incommoded by its long symphysis and tusks: hence we may conclude that the mastodons with great symphyses generally found their nutriment at a certain distance above the soil, and that, consequently, they lived on fruits or leaves rather than on roots. Their teeth seem adapted to crush hard substances; but we must be careful in determining the food of a fossil animal from its dentition, since the narratives of travellers show that Mammals whose dentition is analogous do not always enjoy the same diet. The hippopotamus, though it has the molars of an omnivorist, never feeds upon roots, but exclusively on reeds and herbs.

In connection with the Mastodon Pentelici, Gaudry remarks that the description of the species of the genus Mastodon presents some difficulties. Many of them are widely different: in some the symphysis of the lower jaw is singularly elongated, so as to support a couple of real tusks; in others the lower jaw is short, and bears only two small incisors. Many have their teeth replaced vertically; in others this is not the case. These, in their molars, recall the omnivorous form of boar and hippopotamus; those are more closely related to the tapir and deinothere. Finally, some have three ridges on the intermediate teeth; others, four or five. These differences appear very striking when we are confining our attention to certain species, but are less remarkable when our survey extends over all. For example, it would seem that we ought to admit two natural groups, determined by the form of their teeth; for it is not probable that animals whose molars are constituted according to the tapiroid type should have had the same regimen as those whose molars have a teat-like arrangement. Yet Lartet has remarked that the teeth of the *Mastodon Pyrenaicus* belong to both the tapiroid and teat-like (*mamelonné*) types.

Not only is it difficult to establish distinct groups in the Mastodon genus, but it is not more easy to define the limit which separates it from the elephant; or, rather, the difficulty increases in proportion as paleontological discoveries multiply and fossil remains are more thoroughly investigated.

At first the mastodon was looked upon as forming a very distinct and well-marked group; but, as Science marches forward, the barriers which seemed to separate the primeval forms of organic life are seen to disappear. Cliffe has discovered in India certain species whose teeth establish their transitional rank between the elephant type and the mastodon type. Falconer and Cautley describe an elephant whose milk-teeth were replaced vertically, as in many mastodons; while we know that the elephants and mastodons closely resembled each other in the shape, size, and structure of their limbs. And these facts led De Blainville to propose that the two should be regarded as belonging to one and the same genus. Agassiz points out that the characters which distinguish the one from the other are not more important than those which distinguish the young from the adult elephant.

Mastodontal remains, we may add, have not been found in any abundance in England. The first representation of a British relic was given by William Smith, the father of English geology, in 1816, and is devoted to the last molar tooth of the upper jaw of the *Mastodon angustidens.* Bakewell, in 1836, speaks of the remains of this animal as not having been discovered hitherto in any part of England except the county of Norfolk. A tooth, however, was found at Sizewell Gap, about seven miles from Southwold, in Suffolk; and relics have been exhumed at Euston and Bramerton. Norfolk, however, was, and is, the principal deposit of mastodontal fossils in England.

No genus of quadruped, however, has been more widely diffused over the globe than the mastodon. It has extended from the Tropics, both south and north, into temperate latitudes; and its range included the European as well as the American continent. Professor Owen considers it to have been the first example of the "gigantic proboscidian modification of the mammalian type."

II. THE ELEPHANT.

The bones of elephants are found in extreme abundance in every region of the earth, and even in its superficial strata. These innumerable relics, on account of a certain resemblance between some of the bones of the elephant and the bones of man, have frequently been taken, like those of the mastodon, to be memorials of the past existence of a race of giants. They belong to different species, though Cuvier knew, or admitted, but one—the elephant which the Russians designated the *Mammoth*, and to which Blumenbach gave the name of

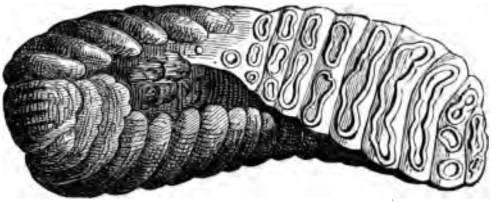
SKELETON OF THE MAMMOTH.

"primeval elephant" (*Elephas primigenius*). It stood from fifteen to eighteen feet in height; was covered with a coarse reddish-brown wool, and with long stiff black hairs, which formed a kind of mane along its back. Its enormous tusks were implanted in longer alveoli than those of our modern elephants; but, in other respects, it was not unlike the elephant of India. It has left thousands of its carcasses from Spain to the ice-bound shores of Siberia; and they are found throughout the North American continent. Everybody knows that its tusks are still so well preserved in cold countries as to be employed for the same uses as recent ivory.

THE MAMMOTH, RESTORED.

We have said that in general character it resembled the Indian elephant, but it differed from it in its possession of a long mane, and of two coats of wool—the one of a soft reddish texture, about nine to ten inches long; the other composed of rough, coarse hair, black, and about eighteen inches in length. These points of difference show that it was organized to live in the bleakest and most inhospitable regions of our globe.

Its skull was elongated, and its forehead concave; the alveoli of its tusks were very long; and the tusks themselves far exceeded in length those of the African elephant, were more curved, and had their extremity inclined inwards. The lower jaw was obtuse; the molar teeth were very large, parallel, and marked with very narrow lines of enamel.



A MAMMOTH'S TOOTH.

Professor Owen shortly states the difference between the skull of the fossil elephant and that of the living animal to be: The more angular form and relative shortness of the zygomatic processes; the longer, more pointed, and more curved form of the postorbital process; the larger and more prominent tubercle of the lachrymal bone; the greater length of the sockets of the tusks, a circumstance to which we have already referred; the more parallel position of the right and left sockets of the grinders, making the anterior interspace and channels at the junction of the rami of the lower jaw, proportionably wider than in the existing elephants.

The grinding teeth of the mammoth form one of its most conspicuous characters; and the eminent writer already quoted justly remarks, that few examples of natural structures manifest a more striking adaptation of a highly complex and beautiful instrument to the necessities of the animal endowed with it.

Thus, he says,* the jaw is not encumbered with the whole weight of the massive tooth at once, but it is formed by degrees as it is required; the subdivision of the crown into a number of successive plates, and of the plates into subcylindrical processes, presenting the conditions most favourable to progressive formation. But a more important advantage is gained by this subdivision of the grinder: each part is formed like a perfect tooth, having a body of dentine, a coat of enamel, and an outer investment of cement; a single digital process may be compared to the simple tooth of a Carnivore; a transverse row of these, therefore, when the work of mastication has commenced, presents, by virtue of the different densities of their constituent substances, a series of cylindrical ridges of enamel, with as many depressions of dentine, and deeper external valleys of cement. The more advanced and more abraded part of the crown is traversed by the transverse ridges of the enamel investing the plates, inclosing the depressed surface of the dentine, and separated by the deeper channels of the cement. The fore part of the tooth exhibits its least efficient condition for mastication, the inequalities of the grinding surface being reduced in proportion as the enamel and cement which invested the dentinal plates have been worn away. This part of the tooth is, however, still fitted for the first coarse crushing of the branches of a tree: the transverse enamel ridges of the succeeding part of the tooth divide the food into smaller fragments, and the posterior islands and tubercles of enamel pound it to the pulp fit for deglutition. The structure and progressive development of the tooth not only give to the elephant's grinder the advantage of the uneven surface which adapts the millstone for its office, but, at the same time, secure the constant presence of the most efficient arrangement for the finer comminution of the food, at the part of the mouth which is nearest the fauces.

---

* Owen, "British Fossil Mammals," pp. 229, 230.

We have referred to the wide range enjoyed by the primeval elephant. It extended over the whole northern hemisphere of the globe, from the 40th to the 60th, and possibly to near the 70th degree of latitude. Our earlier naturalists, misled by the analogy between the existing and extinct elephants, were considerably puzzled to account for the presence of the latter in high northern regions where the former could not possibly live. They attempted to account for the phenomenon by supposing some great change of climate to have taken place,* either gradually, through successive variations in the level of land and sea, or suddenly, through some grand geological catastrophe. Whether such a change has taken place or not, it is certain that the climatic conditions of the high latitudes did not affect the mammoth, whose organization fitted it, as Owen points out, to exist as near the Pole as was compatible with the growth of hardy trees and shrubs. But the question was set at rest by the discovery of an entire mammoth, clad in a double garment of close fur and coarse hair, and therefore adapted to endure the extreme severity of an Arctic winter.

---

* Cuvier, "Ossemens Fossiles," i. 108.

As early as 1692, Isbrant Ides, an intrepid adventurer, who explored the principal regions of Northern Asia, reported that after all the great floods of the rivers and torrents of Siberia, the peasants discovered on their banks, embedded in the masses of earth brought down from the countries they traversed, not only the teeth of mammoths, but even mammoths entire.

A traveller, he says, who accompanied him to China, and who went annually in search of mammoths' teeth, assured him that he had once found, in a mass of frozen earth, the entire head of one of these animals, of which the flesh was corrupted; that the teeth projected from the muzzle like those of elephants, and that he and his companions had much difficulty in extracting them, as well as some bones of the skull, and among others that of the neck, which was still ruddy as with blood; that, finally, having sought further in the same mass of earth, they discovered a frozen hoof of monstrous thickness, which he carried to the town of Tragan. The circumference of this foot was not less than the measurement of a full-statured man around the waist.

The old Siberian Russians, remarks the same authority, believe that the mammoths are simply elephants, though the teeth they found are somewhat more curved, and closer set in the jaw, than those of the latter animals. Before the Deluge, they are wont to say, the country was very warm, and inhabited by numerous herds of elephants, which floated on the waters until they subsided, and were afterwards embedded in the mud. The climate having become very cold after this great cataclysm, the mud froze, and along with it the elephants' carcasses, which were preserved uncorrupted in the earth until revealed by the thaw.

The story runs that, in 1799, Schumachoff, a Tungusian fisherman, discovered at Tamut, on the shore of the Frozen Sea, near the mouth of the Lena, and in the midst of blocks of ice, a shapeless fragment which he could not recognize. In the following year he observed that this mass was somewhat more disengaged from the ice, but still he could not divine what it represented. Towards the end of the following summer, however, the entire side of the animal, and one of its tusks, were free from ice. But it was not until the fifth year, when the ice had melted more rapidly than usual, that the enormous mass was thrown ashore on a bank of sand. In March 1804, the fisherman carried away the tusks, and sold them for fifty roubles. On this occasion a rude drawing was made of the animal, which proved to be no other than the mammoth, as we shall shortly show the reader.

In the year following the fisherman's discovery, Gabriel Saryschew, author of a "Voyage au nord de la Sibérie," found on the banks of the Alaseia, a river emptying itself into the Frozen Sea, eastward of the Indigirska, an entire mammoth, embedded in ice, and left bare by the flood.

It was standing erect, still covered with its skin and coat of long dark hair.

Finally, in 1806, the mammoth discovered in 1799, by the Tungusian fisherman, was visited by Mr. Adams, a professor at Moscow, and member of the Imperial Academy of Sciences at St. Petersburg, who had heard of the remarkable event while passing through Yakutsk. He found it still in the same place, but altogether mutilated. The Yakutski of the neighbourhood had cut off the flesh to feed their dogs, and wild beasts had also fed upon it. The skeleton, however, remained intact, with the exception of one fore-leg. The spine, one scapula, the pelvis, and the three remaining extremities, were still held together by the ligaments, and by parts of the skin. The head was covered with a dry skin. One of the ears, well-preserved, was furnished with a tuft of hair. The point of the lower lip had been gnawed; and the upper one, with the proboscis, having been devoured, the molar teeth could be perceived. The brain was still in the cranium, but appeared dried up. The parts least injured were one fore-foot and one hind-foot; they were covered with skin, and had still the sole attached. According to the statement of its Tungusian discoverer, the animal was so fat that its belly hung down below the joints of the knees. This mammoth was a male, with a long mane on the neck; the tail was much mutilated, only eight out of twenty-eight or thirty caudal vertebrae remaining; the proboscis was gone, but the places of the insertion of its muscles could still be detected on the skull. The skin was covered with black bristles, and with a reddish hair or wool; about three-fourths remained, the weight of which was so great that it required ten people to carry it. The entire skeleton, from the fore part of the skull to the end of the mutilated tail, measured 16 feet 4 inches; its height was 9 feet 4 inches. The tusks measured along the curve 9 feet 6 inches, and in a straight line from the base to the point 3 feet 7 inches.

With great care Mr. Adams collected the remains of this interesting memorial of a past age. Having gathered all the bones, he proceeded to detach the skin from the side on which the animal had lain; and, afterwards, he caused the ground to be dug in different places to ascertain whether any of its bones were buried, but principally to collect all the hairs which the white bears had trod into the ground while devouring the flesh,—and more than thirty-six pounds' weight were thus discovered. The tusks were repurchased at Yakutsk, and the "treasure-trove" despatched from thence to St. Petersburg, where it may still be seen in the Museum of the Petropolitan Academy.

A fragment of the skin and some tufts of the bristles, with specimens of the woolly coat, of a third elephant, exhumed on the borders of the Frozen Sea, are preserved in the Museum of Natural History at Paris.

The old traveller already quoted, Isbrant Ides, records the explanation of these discoveries attempted by the native inhabitants of Northern Asia. They believe that the mammoth is still alive.

Idolaters, he says, such as the Yakutski, the Tungusians, and the Ostiaks, assert that the mammoths have with-drawn into spacious subterranean galleries, whence they never emerge; that they wander to and fro in these galleries, but, as soon as they have passed into one of them, the roof of the cavern rises, afterwards sinks, and forms at this point a tremendous precipice. They are also persuaded that a mammoth dies the moment it sees the light; and maintain that it is thus the animals perished which are found dead on the banks of the rivers flowing near their subterranean vaults, having inconsiderately ventured beyond the confines of the darkness.

A similar superstition exists in the "Celestial Empire." D'Orbigny informs us that, according to the scientific observations of the Emperor Kunghi, the cold is excessive, and almost continuous on the coast of the Northern Ocean, beyond the Tai-tang-kiang. On this coast is found the tan-chou, an animal resembling the rat in form, but *as large as an elephant.* It inhabits dark and gloomy caverns, incessantly flying from the light; and *it yields an ivory*, white as that of the elephant, but more easily worked, because it does not split. Its flesh is very cold, and admirably fitted to refresh the blood. The ancient book "Chou-King" speaks of this animal in the following terms:—"Far in the recesses of the North, among the snow and ice which cover that region, dwells a rat weighing upwards of one thousand pounds; its flesh is beneficial for persons who are overheated."

Shall we ask, with Boitard, whether the tan-chou of the Emperor Kunghi may not be the mammoth, and if, in such a case, the monster animal may not still exist in some secluded and inaccessible region of the globe? But, in truth, such a question is an absurdity, and can only be suggested by the difficulty which some writers seem to experience in accounting for the disappearance of these colossal Pachyderms.

But, apart from any reference to the Darwinian theory of Natural Selection, or any supposition of sudden changes in the climate of the North, or of violent geological cataclysms, it is possible to account for their extinction by a plausible hypothesis. We may say with Brocchi,* that species, like individuals, may have had the cause of death inherent in their original constitution, independently of changes in the outer world, and that the limit of their existence, or the period of exhaustion of the prolific force, may have been ordained from the commencement of each species.

It is noticeable that, notwithstanding the mammoth ranged over Europe even to the extreme West, numerous remains having been discovered in the drift of the British coast, no European nation preserves any tradition of its existence.† Yet in the valley of the Upper Arno they are found in such numbers as to constitute a perfect cemetery; and Germany, France, and Italy have furnished our museums with abundant specimens. The only region in the wide world where they have *not* been met with is Hindustan; that is, one of the two countries which now form the home of the living elephant.

---

* See Sir Charles Lyell's "Principles of Geology."

† Sir J. Lubbock, "Primitive Man," p. 239.

The word "mammoth" is of Russian origin, and, according to Pallas, is derived from the Tartar *mamma*, or earth. Others trace it back to the Arabic *behemoth*, which, in the Book of Job, signifies an unknown but gigantic animal; or to *mahemot*, a descriptive term which the Arabs have been wont to apply to the name of the elephant, when individuals have occurred of unusual dimensions.

To this huge Pachyderm we may apply, not inappropriately, the sonorous verse in which Dr. Young has paraphrased the celebrated allusion to the behemoth in the Book of Job:—

> "Built high and wide, his solid bones surpass
> The bars of steel; his ribs are ribs of brass;
> His port majestic and his armèd jaw
> Give the wide forest and the mountain, law.
> Earth sinks beneath him as he moves along
> To seek the herbs, and mingle with the throng.
> See with what strength his hardened loins are bound,
> All over proof, and shut against a wound!"

III. THE DINOTHERIUM.

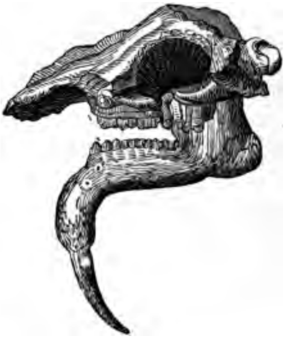
Like the mastodon and the mammoth, the *Dinothere* (or "terrible beast"*) is a Proboscidean, and, like them, it was an inhabitant of Central Europe. Its singularly shaped head, and its colossal dimensions, superior to those even of the two giants we have just named, have rendered it justly celebrated among naturalists. The skull has many points of affinity with the skull of the lamantin—a living herbivorous Cetacean—and its lower jaw terminates with two enormous tusks, curving downward. An entire head, discovered in 1836, at Eppelsheim, in Hesse-Darmstadt, and exhibited at Paris in the following year, measured four feet and a half in length, from the extremity of the temporal bone to the condyli, and upwards of three feet three inches in breadth.

---

* From δεινος, *terrible*, and θηρίον, *an animal.*

A history of the opinions to which the remains of the dinothere have given rise is both curious and instructive.

A few teeth which, towards the close of the last century, were exhumed at different points of France and Germany, first made known its existence. Réaumur and Rosier have figured its molars; Cuvier, who had at his disposal only a few teeth and two jaws, clearly proved that it is not always wise to reconstruct an animal from an extremity of a well-shaped bone; for he described these jaws and these teeth as having belonged to a gigantic tapir—a tapir twenty feet in length!


SKULL OF THE DINOTHERE.

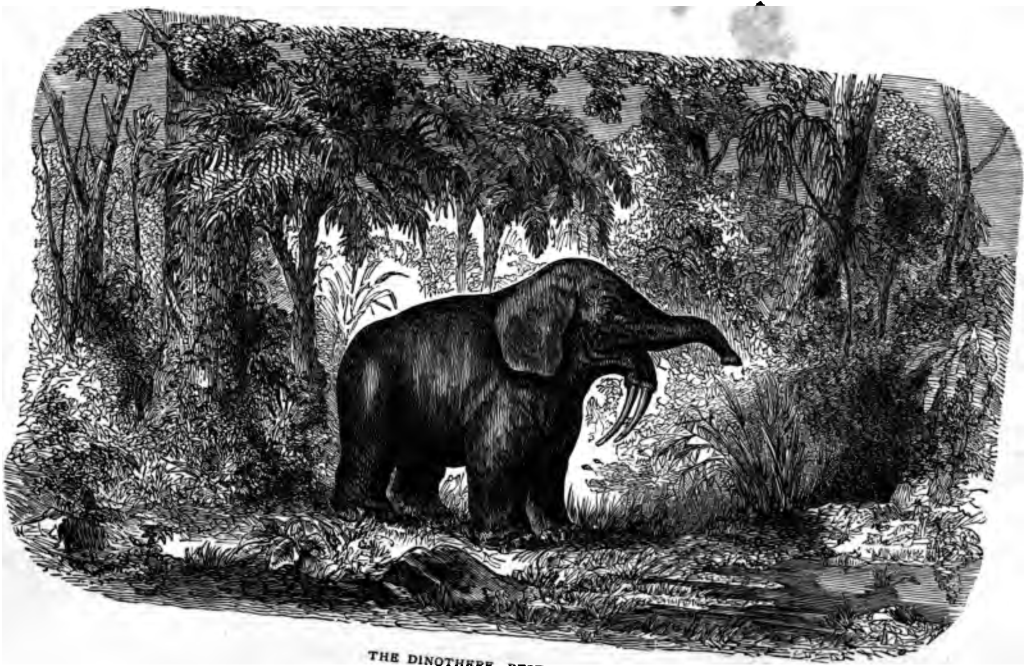
Kaup, after a careful examination of the skull in 1833, defined the genus. And where did he place it? At first between the mastodon and the bradypus. Soon afterwards he constituted it a separate family, in the group of the sloths and pangolins; and, finally, in 1837, he placed it among the pachyderms, properly so called, in a genus allied to the hippopotamus.

On examining this skull, he wrote: "Every zoologist will agree with me that nothing in the world is less infallible than certain theories which, from the inspection of a fragment of bone, pretend to reconstruct at once the whole animal."

Dr. Buckland, writing in 1835, described the dinothere as an aquatic animal. Strauss, in 1837, created it a family of cetacea approximating to the pachyderms; and De Blainville, in the same year, represented it as a genus of mammals, belonging to the dugong and lamantin family.

Finally, in 1856, some bones of the limbs of the tarsus and the carpus, discovered by Gaudry, conducted him, in conjunction with M. Lartet, to the conclusion that the dinothere ought rightly to be classified among the Proboscideans. In 1860 he met with some bones of gigantic size, and of forms until then unknown; namely, an omoplate, a cubitus in connection with the radius, the second, third, and fourth metacarpals, a tibia to which was joined the fibula, a rotulus, and an astragal. Now if, as appears very probable, these bones belong to the dinothere, we have, as Gaudry remarks, a new and irrefutable proof of the justness of the axiom, *That fossil animals frequently borrow their characters from very different genera.*

And, in truth, while the dinothere differs less, in the form and structure of its skull, from the lamantins than the elephants, in its limbs it is widely separated from the former, to approximate very closely to the latter.



THE DINOTHERE, RESTORED.

Roughly speaking, it has a lamantin's head joined to an elephant's body. That is, it is much more closely akin to the elephant and the mastodon, though these two are nearer one another than the dinothere is to either of them.

We see then, to quote again from the great French paleontologist, that even from a perfect and complete skull it was impossible to determine the character of the dinothere's body. To gain a thorough knowledge of the form and structure of its limbs, we must extract them from the rocks in which they lie embedded. The law of connection does *not* enable us to divine their forms.

The stature of the dinothere, taken at the shoulder, must have been thirteen and a half feet. Certainly it exceeded that of our living elephants. Before we can say anything of its habits and mode of life, we must wait until a complete skeleton has been recovered. In particular, we are in want of the phalanges.

The limbs of the animal were made known to us by Gaudry. The pelvis was found by the Père Sanna Solaro.

Its dimensions are enormous: height, about three and a half feet from the lower extremity of the symphysis of the pubis to the extremity of the upper spine of the bones of the ilium; breadth, five feet and a quarter from one ridge to the other of the bones of the ilium. In its form, as in the position which it must have occupied in the living animal, the pelvis differs widely from that of the tapir to approximate to those of the megathere and the elephant. It was straight, as in the latter, while that of the tapir inclines forward.

But one curious point in Solaro's discoveries must not be omitted:—

We know that among the Marsupials, or pouched animals—as, for example, the kangaroo and opossum—the young are delivered in the embryonic condition. They are scarcely born before they cling to the teats of the mother, and thus they remain until their development is complete. In the majority of species the teats are placed in an abdominal pouch, formed by a fold of the skin, at the bottom of which, we may add, the little ones, until they have grown independent, find a refuge and a shelter.

Finally, in all the Marsupials the mammary region is supported by two long bones which articulate on the arcade of the pubis, and to which the distinctive name has very appropriately been given of *marsupial bones*.

It is a remarkable fact, reader, that these very marsupial bones have been discovered by Solaro in the pelvis of the gigantic dinothere; only the osseous stems, instead of springing from the anterior haunch of the pubis, are articulated on, or attached and jointed to, the ilium, in a triangular cavity situated by the side of the cotyloïd cavity. The dimensions of an abdominal pouch, observes Solaro, springing from the pubis, would not have been in proportion to the considerable dimensions of the young dinothere in the second stage of its life.

Like the Marsupials, and like the Monotremata *—as the ornithorhynchus and the echidna—the dinothere must therefore have been an aplacentary—that is, must have been without a placenta. Assuredly this conclusion was wholly unexpected. But that it was a pouched animal, it is evident enough the mere presence of the marsupial bones will not suffice to demonstrate. For these are found in all the Monotremata, and yet the Monotremata carry no abdominal pouch.

---

* *Monotremata* (μονός, *single*, and τρεμα, *an opening*), the lowest order of the Vertebrata, in many features approximating to birds. The skull is smooth; the

The true position of the dinothere in the economy of the Animal World has yet to be determined.

snout considerably elongated; the jaws toothless, and unprovided with soft and flexible lips. The pelvis, as stated in the text, is furnished with marsupial bones; but these animals do not possess a pouch. The mammary gland on either side has no nipple, but opens by a simple slit. All the species are natives of Australia or Tasmania.

BOOK II.—THE BIRDS.

"Meanwhile the tepid caves, and fens, and shores
Their brood as numerous hatch, from the egg that, soon
Bursting with kindly rapture, forth disclosed
Their callow young; but feathered soon, and fledge,
They sunned their pens; and, soaring the air sublime,
With clang despised the ground, under a cloud
In prospect; there the eagle and the stork
On cliffs and cedar-tops their eyries build;
Part loosely wing the region; part, more wise,
In common, ranged in figure, wedge their way,
Intelligent of seasons, and set forth
Their aëry caravan, high over seas
Flying, and over lands, with mutual wing
Easing their flight......
From branch to branch the smaller birds with songs
Solaced the woods, and spread their painted wings
Till even"...... MILTON.

IN the foregoing quotation the poet has painted a very animated and beautiful picture of the creation of the wingèd race; but all his types are existing types, and belong rather to the modern than to the primeval world. It is true, however, that we have not much right to correct his details. In spite of the numerous discoveries made in recent years, the paleontology of Mammals is not very far advanced; but with the paleontology of Birds it is infinitely worse. The science is in its very infancy. And he who would fill the woods and groves of the young earth with feathered inhabitants, must have recourse, like the poet, to his imagination, and deal, to a great extent, with the forms that are now before his eyes.

A naturalist specially distinguished by his researches in ornithology, Prince Charles Bonaparte, very justly observes:—

"The birds have not yet found, like the mammals, their Cuvier, or, like the fishes, their Agassiz—those incomparable historians who have endowed with new life races for ever extinct."

There are various causes of this inferiority, among which our author mentions the following:—

"It is easy to comprehend," he says, "why the determination of fossil birds is difficult, and why the simple inspection of a fragment of injured bone has afforded to certain naturalists an opportunity more convenient than rational for creating new species and genera. We can understand, moreover, how the tolerable uniformity which prevails in the structure of the skeleton of the bird—an uniformity, however, which has been much exaggerated—has enabled superficial observers to shift from one family, and even from one order, to the other, the most distinct and clearly characterized species.

"While saying," continues the prince, "that we frequently exaggerate the similitude of skeletons—of which we generally study only the legs and beak with proper care—we are forced to admit that the type-bird varies, so far as its osseous framework is concerned, much less than that of other vertebrate animals. We might cite a thousand examples for one; and certainly there are few zoologists who can safely decide to what order belongs a skeleton deprived of its beak and claws; and their hesitation, natural enough under the circumstances, has been the cause of the numerous changes from species to species, and genus to genus, of which we have just spoken."

Four years before these remarks were written, M. Pictet, a distinguished French paleontologist, had observed :—

"So great is the want of precise osteological characters, that this branch of paleontology will probably never be established on a basis as rigorous and as sure as that which refers to animals possessing more numerous and more clearly defined osteological differences."

But Progress is no empty word, and the "situation" is not so dispiriting nowadays as it was when Pictet wrote. Though much remains to be accomplished, though we have laid down only the rudiments of the science, enough has been done, at all events, to encourage the paleontologist in further researches.

That we are making no unfounded boast, is shown by the Report which M. de Quatrefages presented to the French Academy of Sciences at its annual meeting in March 1866, on the occasion of the presentation of the grand prize for the Physical Sciences. This prize, offered for the osteological work which should have most contributed to the advancement of French osteology, was awarded to a Memoir, by Milne-Edwards, on "The Ornithological Fauna of the Tertiary and Quaternary Epochs."

Now, from the researches described in this elaborate work, it appears that the bones of birds which have best resisted the action of time, and which figure most frequently in our collections—namely, the long bones—present for the determination of species as many resources as those (for instance, the head and beak) whose fragility has ensured their universal destruction.

Among these there is one which specially deserves attention,—the tarso-metatarsus, vulgarly called *the bone of the ankle.* Destined to support the whole weight of the animal, it possesses an exceptional solidity. Moreover, the projections and depressions of its surface are necessarily in relation to the tendons of the muscles of the feet which skirt it from one extremity to the other, and the solidity of the *ensemble* requires that these projections and depressions should be strongly marked. Hence it results that in the tarso-metatarsus we obtain, as it were, a reflection of the structure of the foot.

Now, we know how important is the part ascribed in the classification of birds to this part of the body, which is necessarily in harmony with the animal's mode of life. From these facts already known one would have been able to conjecture that the tarso-metatarsus would possess a singular importance in such researches as those which here concern us. Milne-Edwards fully confirms this deduction, and even goes beyond it. From the totality of his studies he finds himself able to conclude that this part of the skeleton possesses a remarkable fixity, and may be employed for zoological determinations in the case of birds with no less safety than the constitution of the dental system in the case of mammals.

Thus, then, a sufficiently careful investigation of bones has dissipated the prejudice which, by erroneously attributing to them a very great uniformity in birds, was an obstacle to the progress of paleontological ornithology.

Let us admit, nevertheless, that after the experience acquired in Mammalogy—an experience which, as we have seen, allows us to place only a limited confidence in principles of determination which, at the outset, seemed worthy of implicit trust—we cannot, and we must not, hope that the inspection of a metatarsus will always suffice for the reconstruction of a fossil bird.

It is clear, however, that the metatarsus *does* furnish us with resources which we were far from suspecting: this is a first point gained, a considerable point; and a further reference to the Memoir by M. de Quatrefages shows that the persevering study of fossiliferous deposits clears away another preconceived opinion, not less prejudicial than the former.

Every naturalist has agreed in saying that fossils of birds are, comparatively, very rare. It is, at all events, certain that they are so in our collections; but M. de Quatrefages proceeds to demonstrate that the rarity has been due to the negligence of collectors. And having undertaken some explorations in the localities which appeared to him most likely to reward his trouble—as at Sansan, and at St. Géraud-le-Puy, in the department of the Allier—he accumulated, in four years, no less than four thousand specimens. No public collection possesses such a number. In the midst of masses of concreted limestone which are worked as a quarry, masses of fine sand are met with, mixed with minute calcareous *débris*. It is here that the bones of birds are most frequently found, and, generally, in an excellent state of preservation.

Sometimes the different parts of the same skeleton are found lying together; but, as a rule, the bones are isolated. In the same locality, or in the neighbourhood, the geologist will also come upon entire eggs—eggs with the shell unbroken—and even upon the imprints of feathers sufficiently distinct to enable him to recognize the arrangement of the barbs.

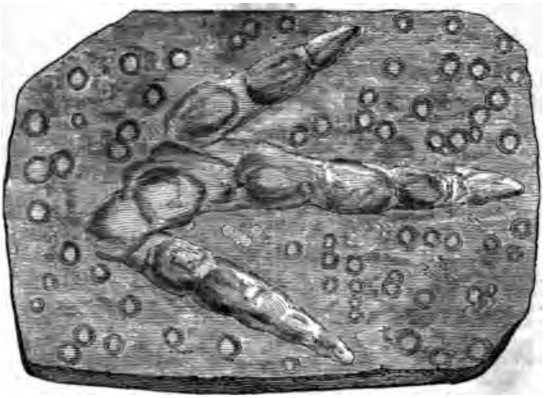
Having thus reassured ourselves as to the future of this branch of paleontology, in which the elements and conditions of progress are no more wanting than they are in other branches of the science, we proceed to a brief description of some of the more remarkable species of fossil birds.

We may premise that the earliest remains (those of the Archaeopteryx, or Bird of Solenhofen) have been discovered in the Upper Oolite. No traces of birds have as yet been recognized in either of the more ancient formations.

I. THE BIRD OF MASSACHUSETTS.

At the epoch when the Red Sandstone of the United States deposited underneath the primeval waters its regular strata, there lived an animal known to us only by the footprints which it traced on the soft and plastic soil.

The sandstone of Massachusetts has faithfully preserved for our edification and astonishment these curious memorials of a past age of the world's history. And in their neighbourhood are also visible the marks of the rain-drops which fell in that remote and obscure era. It is difficult to think of any circumstance more calculated to stir the imagination. Here, in the solid rock, we may read, as it were, the handwriting of the Past; may see the impressions of birds whose species wandered over the earth thousands and thousands of years ago; may listen, so to speak, to the plash of the heavy rains which then fell from the "darkened vault" of heaven!



IMPRESSIONS OF RAIN-DROPS, AND OF A BIRD'S FOOT, IN THE MASSACHUSETTS SANDSTONE.

The reader will wonder, perhaps, that while these traces of the bird's footsteps have been preserved, not one of its bones should be anywhere discoverable. But this is not peculiar to the mysterious bird of the Red

Sandstone period. The same sandstone which has revealed to us its existence, shows upwards of fifty varieties of impressions, ascribed to as many distinct animals, each of which, so far as is yet known, has bequeathed to the present no other memorial of the past.

The true character of the impressions to which we refer cannot now be doubted by any paleontologist. Mr. Hitchcock, who has investigated them with great care, has proved, by his elaborate researches, that they cannot possibly be ascribed to any other class of animals than that of birds. They generally exhibit the marks of three toes, of which the longest is the central.

Though Mr. Hitchcock's studies led him to this conclusion, our geologists long hesitated to accept it, from the apparent improbability that a bird should have lived at so remote an epoch. The sandstone with which it was contemporary belonged to the Triassic age. But numerous facts recently discovered, and well established, have taught us that a crowd of animals (mammals, among others, and saurians) are of far greater antiquity than geologists, at first, were willing to believe; and the ornithological origin of the footprints in question need no longer excite suspicion.

These footprints, as Hugh Miller remarks,* tell their extraordinary story with remarkable precision and distinctness; so that we can almost dispense with any other remains. They were apparently all of the *Grallae*, or Stilt order of birds: an order including the cranes, herons, and bustards, ostriches and cassowaries; and characterized by possessing no more than three toes on each foot, or, if a fourth toe be present, it is so imperfectly developed in most cases as to fail to reach the ground. In almost all the footprints of primeval birds found in the Red Sandstone of the Connecticut Valley, there are only three toes exhibited.

---

* Miller, "Testimony of the Rocks," pp. 81–83.

Some of the impressions are remarkably distinct. Each claw, each phalange has left its mark in the stone; while the triple termination of the tarso-metatarsal bone leaves three marks more—fifteen in all—the true ornithic number. They are of great size; not unfrequently measuring eighteen inches in length from the heel to the middle claw, and nearly thirteen inches in breadth from the outer to the inner toe: indicating a stride of about two yards in the creature that impressed them in these ancient sands.

They are fraught with strange meanings, says Hugh Miller, these footprints of the Connecticut. They tell of a time far removed into the by-past eternity, when great birds frequented by myriads the shores of a nameless lake, to wade into its shallows in quest of mail-covered fishes of the ancient type, or long-extinct molluscs; while reptiles equally gigantic, and of still stranger proportions, haunted the neighbouring swamps and savannahs; and when the same sun that shone on the tall moving forms beside the waters, and threw their long shadows across the red sands, lighted up the glades of deep forests, all of whose fantastic productions—tree, and bush, and herb—have even in their very species long since passed away. And of this scene of things only the footprints remain—"footprints on the sand of time," which cannot but excite us to admiration and wonder.

II. BRITISH FOSSIL BIRDS.

1. *Cimoliornis*[*] *Diomedeus—Long-Winged Bird of the Chalk.*

(Osteornis Diomedeus, *Gervais*).

According to Professor Owen, the most complete and characteristic of the few actually fossilized remains of birds which have been discovered in England, are those from the London clay. Some fragmentary ornitholites have been discovered in the older Pliocene crag, and in the newer Pliocene deposits and bone-caves. But very scanty hitherto have been the recognizable remains of birds from the Chalk formations.

The fossils on which the *Cimoliornis Diomedeus* was founded were obtained from the chalk near Maidstone, and consist of portions of its wing-bone, twelve inches long, and the distal end of the tibia. Professor Owen, after a minute analysis of their characters,[†] refers them to one of the long-winged swimming-birds, equalling in size the albatross.

2. *Lithornis Vulturinus—The Vulture-like Lithornis.*

The fossils of this bird, including the sternum and the sacrum, two very characteristic parts, were discovered in the London clay at Sheppey. They were found to possess considerable resemblances to corresponding portions of the skeletons of the Accipitrine species, though these resemblances were not sufficient to admit of the fossil being referred to any of the existing native genera of Raptorial birds. It seems to have been very similar in structure and organization to, but smaller than, our present turkey-vulture (*Cathartes aura*).

---

[*] From *κιμωλία*, *chalk*, and *ὄρνις*, *a bird.*

[†] Owen, "British Fossil Mammals and Birds," p. 547.

3. *Halcyornis toliapicus—Bird probably of the Family Halcyonidae.*

The fossil cranium on which Professor Owen determines this genus was found in the London clay at Sheppey. It bears a greater resemblance to the cranium of the king-fisher than to that of any other bird.

4. *Small Wading-Bird* (*Order, Grallatores*).

In the London clay, near Primrose Hill, was discovered the sternum of a small wading-bird, which appears to have belonged to the *Ardeidae*, or Heron family.

Professor Owen also speaks of having recognized the humerus of a bird of flight, about the size of a barn-owl, in a bed of Norwich crag; and Dr. Buckland figures the fossil humerus of a bird, as large as that of a wild-goose, from the diluvial clay of Lawford. In the bone-cavern at Kirkdale the latter geologist found the ornitholites of ravens, larks, pigeons, a small species of duck, and a bird not ascertained, being about the size of a thrush. Remains of a small wader and of a falcon, rather larger than the *Falco peregrinus*, have likewise been discovered. But these are not actually fossil species.

III. THE GASTORNIS PARISIENSIS.

The *Gastornis Parisiensis* dates from a distant epoch, though it cannot lay claim to the venerable antiquity of the so-called Bird of Massachusetts.

Its bones have been discovered in the lowest bed of the Tertiary, in a kind of conglomerate which has filled up the fissures and interspaces of the Chalk.

Though inferior in size to the Bird of Massachusetts, its proportions, nevertheless, compared with those of existing birds, were gigantic.

It was, in truth, as tall as the ostrich, as big as a horse: it swam like a swan; but slept, standing on one leg, like a stork. According to Milne-Edwards, its characters, in the main, are those of the order of *Grallatores*, or Waders. The imprints of footsteps of colossal birds found in the Eocene gypsum by Desnoyers, were probably made by the gastornis.

This monster of the old world was discovered in 1855 at Bas-Meudon, near Paris. It received its name from M. Constant Prévost, in honour of M. *Gaston* Planté, the discoverer. The first thing found was a tibia, whose dimensions were: length, 450 millimètres; breadth, in the middle, 80 millimètres; and at the top, which was flattened, 95 millimètres. A few days afterwards, in the same locality, and at about ten feet distant horizontally from the point where the tibia had been picked up, a femur rewarded the researches of M. Planté.

The tibia, according to Hébert, was covered externally with a thick crust of crystallized sulphate of lime; the interior was filled with the same substance, mixed with clayey and ferruginous matter. The cracks and indentations in the bone were likewise occupied by crystals of gypsum. The repository of the fossil is, therefore, incontestable, and belongs to the stratum in which it was found by Planté; it could not have been introduced therein posteriorly.

M. Constant Prévost has also shown that the argillaceous bed in which the gastornis lay could not have been the product of an upheaval or landslip later than the deposit of the gypsum.

How many ages have rolled by since then! Neither the cavernous millstones, nor the marine sandstones, nor the oyster-marl which may be seen in the neighbourhood of Paris, nor the gypsum of Montmartre and the surrounding hills, nor the freestone whose solid strata serve as a foundation for the French capital, were then in existence. The future site of Paris was covered by the waters, and the materials from which its mansions and palaces were to be constructed were being slowly deposited in the depths of the primeval sea.

IV. THE DINORNIS AND THE PALAPTERYX.

In opposition to the birds we have previously noticed, the *Dinornis* and the *Palapteryx* belong to a very recent epoch, for we find them in the diluvial deposits of New Zealand. So far as stature was concerned, they surpassed the gastornis; the latter was not taller than a modern ostrich, while one of the species of dinornis was upwards of thirteen feet in height.

Its name, which signifies "the prodigious bird," may therefore be regarded as fully justified. It was conferred upon it by Professor Owen; but the bird is identical with that which the natives of New Zealand call the *Moa*.

That of Palapteryx signifies "ancient wingless birds" (παλαίος, *ancient*, and απτερόν, *wingless*).

These fossil genera occupy an intermediate position, so far as form is concerned, between the cassowary and the apteryx.

Our first direct proof of the existence of the moa was obtained in 1839. At that epoch a fragment of an enormous bone was sent to London; you would have thought it the bone of an ox, but Professor Owen perceived that it had belonged to a colossal bird—of a bird larger than the ostrich. You may conceive the astonishment of naturalists at this discovery, and their admiration of the scientific skill which had led to it.

Four years later, the missionary Williams sent to Dr. Buckland, the eminent geologist, several chests filled with bones of moas, collected in the North Island of New Zealand. Dr. Buckland presented them to the Museum of the Royal College of Surgeons.

Some eleven or twelve years ago, Mr. Walter Mantell, in the course of an exploration of the two islands, accumulated upwards of a thousand bones, which were purchased by the British Museum. And Hochstetter tells us he shall never forget the impression produced upon his mind by the appearance of these bones and skeletons, when he entered, for the first time, the northern gallery of the museum. At that time he was preparing to join, as naturalist, an Austrian expedition of discovery in the frigate *Novara.* We shall allow him to describe the consequences of his inspection of the moas in his own language :—

"Some weeks had to elapse," he says, "before the frigate's departure. Among the islands of the South Sea we intended to explore, New Zealand occupied a foremost place. After seeing in London these enormous bones, the hope and desire never quitted me of bringing back from New Zealand similar treasures for our Austrian museums. My hopes and wishes, however, would have been deceived had not chance willed that, on our arrival, I should be separated from the expedition to make a long sojourn in New Zealand.

"Spite of this favourable circumstance, my efforts, in the earliest months of my stay, were not successful. I had explored all the regions of the North Island, celebrated, some few years before, as the principal repositories of the bones of the dinornis; I had explored all the moa-caverns without discovering a trace of what I was in search of. The amateurs who had visited these places before me, had carried off the very last bony fragment; and the Maoris, seeing that they might turn to advantage these products of their soil, had collected all they could find, and sold them at a very high rate to European curiosity-hunters. The only remains of these treasures which I could unearth were two bones that an old chief of Touhoua had concealed for a long time in his cabin; he extracted them from the hole where he had buried them, and exchanged them, after protracted negotiations, for a woollen coverlet and a little money. They were the pelvis of a smaller species, and the tibia, slightly smoked, of another and equally little species; the chief had long made use of the latter as a club."

Shortly afterwards, while travelling in the Middle Island, M. d'Hochstetter was informed by some miners in the province of Nelson of the existence of a newly-discovered cavern, where the almost complete skeleton of a gigantic bird had been met with. And, according to these people, there was still a quantity of bones in the cavern. Hochstetter repaired thither immediately, and had the satisfaction of extracting some osseous relics from the soil.

He therefore undertook some more extensive researches, which proved so productive that at the end of three days he had collected the skeletons, more or less complete, of ten individuals belonging to six or seven species. These precious treasures are, at the present day, among the most valued contents of the Museum of Vienna.

Quite recently—namely, in 1864—Mr. Alldis, the naturalist, has presented to the Linnaean Society of London a great number of bones representing an almost complete skeleton; a skeleton of so recent a species, that the cartilages still cling to the bones, as well as the tendons, of which many were very elastic.

The discovery was made by some gold-seekers near Dunedin, and the bones were found in a situation which suggested the conjecture that the moa had died on the spot, and on its nest. Its skeleton covered the bones of several young, and the whole were embedded in shifting sand.

These facts will suffice to prove the abundance of the remains of the gigantic dinornis.

From articles by Professor Owen and Dr. Buckland we gather, that the birds named moas in New Zealand belonged not only to a sufficiently large number of species, but even to several different genera.

One of these genera is the Dinornis;

The other is the Palapteryx.

The former had but three toes; the latter had four.

One of the most curious species is that which has been named *Dinornis elephantopes.* It is not the largest; it is much inferior in size to the *Dinornis giganteus,* since it is not above five feet high; but the solid and massive structure of its feet, which is not without an analogy in the feet of the Pachyderms, renders it extremely remarkable. Its skeleton figures in the British Museum, side by side with that of the great mastodon of the Ohio.

The *Palapteryx ingens* was from seven feet and a quarter to seven and a half feet in height. The anterior extremities of its wings, which are much more rudimentary than in the ostrich, are scarcely indicated. On the anterior border of the sternum may be remarked two slight cavities or depressions, to which the rudimentary bifurcate bones are adapted: they are barely two inches long; but there is no articular facet, properly so called. The omoplate and the pterygoïd apophyses were, in all probability, conspicuous by their absence in this bird.

In the Museum at Vienna stands a plaster model of the skeleton of this species. It has no visible support. The legs are traversed by iron rods, which give them more solidity; and the whole occupies that position of equilibrium which the bird must have affected when living, to be able to balance its enormous body on its great feet.

This valuable model was constructed by Dr. Jaeger. The original bones were nearly all restored, in a more or less complete manner, before he attempted to cast them in the plaster. Many parts of the osseous framework, such as the femurs, were wholly wanting, so that he was compelled to model them on the corresponding parts of an individual of larger size which fortunately existed in the same collection. The pelvis was considerably damaged; but he contented himself with completing it by following the contours of the pelvis of a smaller but closely-allied species which M. d'Hochstetter had brought from New Zealand, and which was in a state of very satisfactory preservation. The skull was also very rudimentary; but, by rare good fortune, in the same cavern which had furnished these relics was found another cranium, absolutely intact, and still of a very fresh aspect, which belonged to a more developed individual of the same variety, as was proved by a comparison of its cranium with the other and rudimentary cranium. This, in truth, is the best-preserved of all the crania of New Zealand birds which have up to this day been discovered. The small bones and nasal organs are still in perfect preservation: the jaw alone had to be made up of fragments. And then this cranium served as a model in the arduous restoration of the skeleton of the Palapteryx.

V. THE EPIORNIS.

The *Epiornis*, another gigantic bird, is found only in the superficial or most recent strata of our globe. Its existence was first ascertained at Madagascar.

On the 27th January 1851 M. Geoffroy Saint-Hilaire announced to the scientific world that he had received from M. de Mallevoix, a settler in the island of Reunion, some bones and eggs establishing the important fact that a gigantic bird, previously unknown to science, had lived at Madagascar.

The capacity of one of the eggs received at the Museum of Natural History was no less than eight litres, three quarts; which is nearly six times that of an ostrich's egg, one hundred and forty-eight times that of a hen's egg, and fifty thousand times that of a humming-bird's egg.

In this astounding giant Saint-Hilaire recognized the type of a new genus in the group of the Brevipennata, or Short-Winged (as the ostrich); and he bestowed upon it the name of *Epiornis*, or "the Great Bird."

But, more recently, far larger bones than those examined by Saint-Hilaire have been discovered; and it is known that the Great Bird of Madagascar must have stood thirteen feet in height.

Who can wonder that the existence of such a fossil should have attracted the curious attention of scientific men? But, in fact, it had been known long before. In the seventeenth century some Malagasy, visiting the Mauritius to purchase rum, carried with them vessels which were simply the eggs of the epiornis. Each was about the size of eight ostrich's eggs; but the fact seems to have passed unnoticed.

At a still earlier date men had laughed at the narrative of Marco Polo touching a gigantic bird; a prodigious eagle, the ruc or roc, which had once inhabited Madagascar. It was looked upon as a traveller's fable. But not only has the discovery of the eggs and bones of the epiornis afforded a solid basis for the supposed fable, but, if the conjectures of M. Joseph Bianconi of Bologna are correct, Marco Polo will have been much nearer the truth in every respect than we have been apt to think him in these incredulous days.

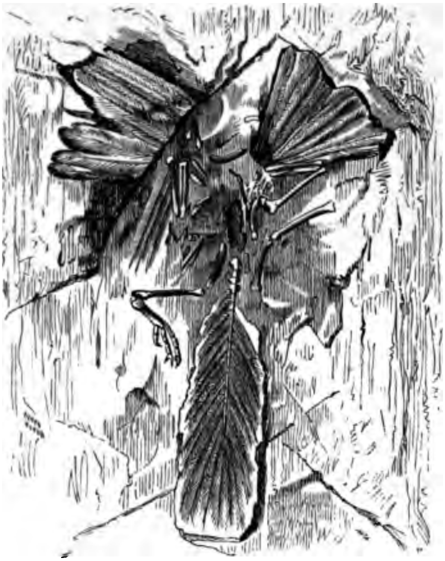
According to Bianconi, the epiornis was *not* a member of the Brevipennates, but belonged to the family of the Vulturidae; was, in fact, a vulture four times larger than the condor. This giant, therefore, must have been endowed with the faculty of flight. The Italian anatomist founds his hypothesis on the conformation of the metatarsal bone of the epiornis.

"A peculiar interest," he writes, "has guided me towards these researches. Marco Polo, in his 'Voyages,' asserts that the colossal bird of Madagascar resembled an immense eagle. This statement has been invariably put aside as a mistake or a fiction; and the remains of the epiornis have generally been considered as those of a short-winged bird. It seems, on the contrary, very probable that the Venetian traveller, on this as on all other points, should have furnished us with a truthful relation."

From these data the reader will see that the reconstitution of the epiornis is not so far advanced as that of the dinornis; for of the former our paleontologists have recovered as yet but a few scattered bones. As for its eggs, the reader may judge of their rarity from the fact that in 1852 the Museum of Paris purchased three at a price of five thousand five hundred francs. We may reasonably hope, however, that as Madagascar becomes better known to Europeans, and its inland recesses are opened up to the adventurous researches of science, we may meet with more perfect relics of the colossal bird whose structure and organization are shrouded as yet in so complete a mystery.

VI. THE ARCHAEOPTERYX.

The *Archaeopteryx*, discovered in the quarries of Solenhofen, in Bavaria—quarries excavated in the Jurassic formations, and evidently of chalky origin — was so named in 1861 by Hermann de Mayer, who at the time was acquainted with only a single feather of it. Soon afterwards there was extracted from the quarry which had furnished this precious relic a stone containing a considerable portion of the skeleton of the same animal, whose anterior limbs seem to have been garnished with long radiating feathers, and whose tail was likewise fur-


THE ARCHAEOPTERYX.

nished with feathers, and of an extreme length. Wagner, in the belief that he had discovered a species of feathered pterodactyl, proposed to call it the Gryphosaurus.

The stone in which the fossil lies imbedded, is now preserved in the British Museum, whose authorities purchased it for a sum of £950.*

The femur or thigh-bone, the tibia, the metatarsus, and the toes, present an unmistakable ornithological character. The same may be asserted of the anterior limbs, except that two of the wing-fingers terminate in claws, while among our living birds never more than one finger is thus provided. The ribs are frailer than in the majority of the feathered race, and do not appear to have had a recurrent apophysis: in this respect approximating to the reptiles, and indicating a respiration of no great activity compared with the bird's length. The tail is that of a reptile, and yet a bird's in its feathers. It may be, on the other hand, that the body was without feathers; at least, no trace of their presence has been detected—a circumstance which, added to the slenderness of the sides, would prove that the temperature proper to the animal was very little higher than that peculiar to reptiles.

In the same stone was found a jaw bristling with teeth, which Professor Owen assigned to a fish.

---

* There was found, on the same occasion, a large and valuable collection of crustaceans, fishes, and reptiles, which the British Museum was obliged to purchase in order to obtain the fossil gem.

BOOK III.—REPTILES.

> "Are God and Nature then at strife,
> That Nature lends such evil dreams,
> So careful of the type she seems,
> So careless of the single life?
> 'So careful of the type!'—but no!
> From scarpèd cliff and quarried stone
> She cries—'A thousand types are gone;
> I care for nothing,—all shall go.
> Thou makest thine appeal to me:
> I bring to life, I bring to death,—
> The spirit does but mean the breath.
> I know no more.'" . . . .
>
> TENNYSON, *In Memoriam.*

> "Dragons of the prime,
> That tare each other in their slime."
>
> *Ibid.*

PROFESSOR OWEN sums up the results of his elaborate researches into the structure and organization of the fossil Reptilia with the pregnant remark: "The fossil reptiles demonstrate how artificial is the distinction the naturalist seeks to establish between the reptile and the fish; they prove how complete is the unity between the cold-blooded Vertebrata."

In the following pages frequent opportunities will occur of confirming the truth and sagacity of the Professor's assertion.

We shall confine ourselves to the Saurian group, as, in a paleontological sense, the most interesting.

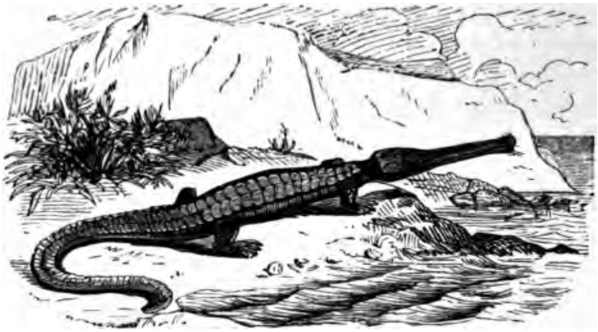
For a considerable period the most ancient vestiges of the primeval Saurians were found in the Zechstein, or Permian beds, of Germany. Twenty-two years ago not one was known which dated from the Carboniferous period, and it was believed that no animals of higher organization than fishes had lived at that epoch. But nowadays we know that it possessed at least eighteen genera of reptiles. Nor is this all : some crocodiles' bones were discovered six or seven years since in the Upper Triassic beds of Scotland; and, more, impressions of the footprints of reptiles have been traced on the shores of the great lakes of North America, in sedimentary strata probably far more ancient than the sandstone.

As a rule, the reptiles which preceded the Permian epoch approximate in their organization to the lower Batrachians, and even to certain fishes. These, as Gaudry remarks, are singular vertebrates, of indecisive characters, which seem to represent the embryonic age of reptiles, and to form a transition between fishes and reptiles properly so called. And D'Archiac cites this fact as justifying the idea of the development and gradual perfecting of beings in the series of the geological ages, whether we consider the organism as a whole, or a class of vertebrate animals in particular.

I. THE TELEOSAURUS.

The *Teleosaurus* was so christened by Geoffroy Saint-Hilaire. In the general conformation of its head, and in its narrow, slender jaws, it approximates to our living gavials, but its sternum is that of a crocodile. Its teeth were thin, conical, sharp, and uniform; its lower jaw widened at the extremity.

Certain species measured as much as thirty-three feet in length, three of which were occupied by the animal's head.



THE TELEOSAURUS, RESTORED.

The *Teleosaurus cadomensis*, described by Eudes Deslonchamps, carried a couple of cuirasses: one on the back, like our present crocodiles, the other on its belly. Its awful jaws, which were well defended beyond the ears, opened as wide as six feet, through which it could engulf, in the depths of its cavernous palate, animals of the size of an ox.

II. THE MEGALOSAURUS.

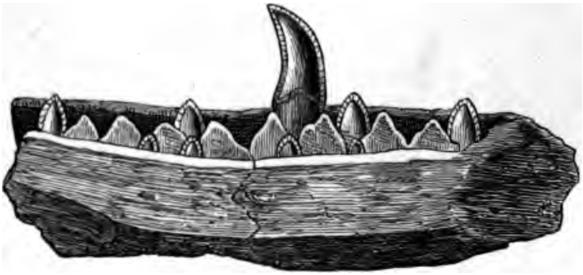
The *Megalosaurus* (from *μέγας*, *great*, and *σαῦρος*, *a lizard*) measured thirty-eight to forty feet in length.

Its muzzle was straight, thin, and laterally compressed, like that of the gavial; but its compact teeth, sharp, arched in front, with two finely dentated ridges, constituted, as the reader may judge from the accompanying illustration, a truly formidable apparatus.

THE MEGALOSAURUS, RESTORED.

Thus organized, we cannot doubt that the megalosaurus, as Cuvier says, was an animal of exceeding ferocity. "With teeth constructed," says Dr. Buckland, "so as to cut with the whole of their concave edge, each movement of the jaws produced the combined effect of a knife and a saw, at the same time that the point made a first incision, like that made by a double-cutting sword. The backward curvature taken by the teeth at their full growth, renders the escape of the prey when once seized impossible, just as the barbs of an arrow render its withdrawal impracticable. Here, then, we meet with the same arrangements which enable mankind to put in operation many of the instruments which they employ."

The mode in which these teeth are set in the jaw is not less remarkable than their form. It is, in truth, the transition between the dentition of the crocodile and that of the lacertidae. The jaw has an outer edge, as in the lizards, but the teeth are fixed against it in separate sockets, formed by transversal partitions. Probably these animals frequented the river-banks, where they fed upon reptiles of moderate size; and tortoises, and even numerous saurians would meet with no quarter from them, as is proved by the presence of their *débris* in the same localities as those of the megalosauri.



JAW OF THE MEGALOSAURUS.

This saurian was discovered in the Oolitic strata of Stonesfield. Its remains consisted of a portion of the jaw, some long bones, some vertebrae, a coracoid, and the like. It was fully and graphically described by, Dr. Buckland.* From the dimensions of the coracoid, Cuvier supposes that the *Megalosaurus Bucklandi* may have been some seventy feet in length; but in this he is wrong by *one half.*

The complex structure and wonderful arrangement of the teeth are a sufficient proof that this huge and formidable saurian was essentially carnivorous. It may briefly be described, for the information of the non-scientific reader, as an enormous lizard, supported upon slightly-raised feet, with a head like that of the gavial, or Gangetic crocodile.

III. THE HYLAEOSAURUS.

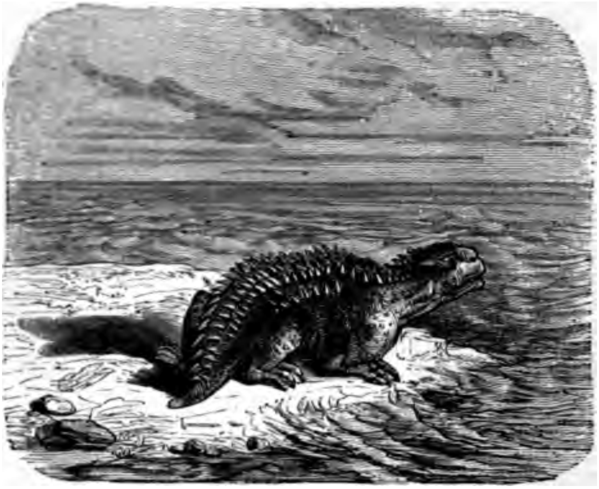
In Tropical America is living at the present day a saurian varying in length from four to five feet; we mean, the Iguana. A ridge or crest of large horny spines extends the whole length of its back and over a part of its tail.

The same arrangement existed in the primeval iguana, the *Hylaeosaurus*, or forest-lizard (from ὕλη, and σαῦρος). Only these scales were much longer and stronger in the primeval than they are in the living iguana, and the former was fully twenty-five feet long. Moreover, it possessed, what its descendant does not, a cuirass of great osseous plates, lodged under its skin.

The discovery of this portentous saurian was made by Dr. Mantell, in 1832, in Tilgate Forest, near Cuckfield, Sussex—a part of the ancient Andredes-weald.

---

* See Dr. Buckland's admirable Bridgewater Treatise.



THE HYLAEOSAURUS, RESTORED.

IV. THE IGUANODON.

Of more formidable dimensions than the megalosaurus was the *Iguanodon* (or "iguana-toothed"), which, so far as our researches have hitherto extended, must be pronounced the most gigantic of all the primeval saurians. Professor Owen differs from Dr. Mantell in his estimate of the animal's length, which the latter, attributing to it a very long tail, makes from fifty to sixty feet. If it had a short tail, these figures would be reduced to forty or forty-five; or, according to Professor Owen, to twenty-seven. The one calculation is perhaps as much too low as the other is too high. However, the largest femoral bone yet discovered measures four feet eight inches in length.

The comparative dimensions of its bones show that it stood high on its legs, the hind-limbs being much longer than the fore, and the feet short and massive. The form and disposition of the feet show that it was a terrestrial, as its dentition proves it to have been an herbivorous, animal.

THE IGUANODON, RESTORED.

It was in reference to its dentition that Mantell gave it the name *Iguanodon*. They are not set in distinct sockets, like those of the crocodiles, but attached to the internal face of a dental bone, as in the iguana. The teeth were forwarded by Mantell for Cuvier's inspection, and the great anatomist agreed in the opinion that they had belonged to a sau-

TOOTH OF THE IGUANODON.

rian. These teeth, as our illustration shows, are prismatic, broader on the outside than on the inside face, and marked by three blunt, longitudinal, keel-shaped ridges.

The iguanodon carried a horn on its muzzle. A skeleton, nearly perfect, was discovered by Mantell in Tilgate Forest.

V. THE MOSASAURUS, OR GREAT ANIMAL OF MAESTRICHT.

The history of the discovery of the *Mosasaurus* is an interesting geological romance. And no animal has been the cause of more lively controversies among scientific men—a race much given to controversy.

Maestricht, we need hardly tell the reader, is a city of the Netherlands, built on the banks of the Meuse. Among the hills on the western side of the river a solid mass of cretaceous formation known as St. Peter's Rocks has long been the site of some extensive quarries. Numerous fossil remains were at different times discovered here, and an officer of the garrison, named Drouin, formed a collection which, in 1766, was purchased by the authorities of the British Museum. Drouin's example was followed by a military surgeon, named Hoffmann, who, in 1780, purchased of the quarrymen a remarkable fossil head, upwards of six feet in length.

So great a prize attracted very general attention, and the Dean of the Chapter of Maestricht, one Goddin or Godwin, was induced to claim it from its purchaser on the ground that he was proprietor of the land where the fossil had been exhumed. He brought an action at law in assertion of his right, was successful, and received the much-coveted treasure.

In 1793 the French army, under General Kleber, laid siege to Maestricht. Attached to the staff as Scientific Commissioner was the celebrated geologist, Faujas de Saint-Fond. Of all the spoils of the city Faujas coveted only the celebrated "head;" and, at his request, when Maestricht was bombarded, Goddin's house was spared, just as, of old,—

"The great Emathian conqueror bid spare
The house of Pindarus, when temple and tower
Went to the ground."*

The city surrendered. Faujas hastened to Goddin's mansion; but the much-coveted fossil had been removed. It is said that the representative of the people who then accompanied the army promised six hundred bottles of good wine to the soldier recovering the precious spoil. On the following morning twelve grenadiers triumphantly brought it into the camp; it was packed with the utmost care, and despatched to the Museum of Natural History in Paris. It is but fair to add that its former proprietor was compensated for his loss with a handsome sum of money.

Faujas de Saint-Fond immediately occupied himself in studying his fossil, and published the result of his investigations in a work entitled, "Histoire naturelle de la Montagne de Saint-Pierre, près Maestricht;" but he had been anticipated.

Pierre Camper and Van Marum had obtained possession of fragments of the same animal, exhumed in the same locality. They had purchased them of the heirs of the surgeon Hoffmann; and persisted in attributing them to a whale, contrary to the opinion of their original owner, who had ascribed them to a crocodile. Adrian Camper, in 1790, directing his attention to the same subject, demonstrated that the "animal of Maestricht" was neither a whale nor a crocodile, but a new genus of saurian akin to the existing monitor. He pointed out, as specially distinguishing this saurian from a crocodile, the polish of the bones, the apertures in the lower jaw for the egress of the nerves, the full solid root of the teeth, the attachment of the teeth to the palate, as well as certain obvious differences in the vertebrae.

---

* Milton, "Sonnets," viii.

Faujas, however, refused to abandon his theory, until Cuvier descended into the arena, and, with all his wonted sagacity and insight, demonstrated its absurdity. The mosasaurus (or "lizard of the Meuse") was neither a crocodile nor an iguana; and these two animals, said Cuvier, differ as much from each other in their teeth, bones, and viscera, as the ape differs from the cat, or the elephant from the horse.

But while the great French anatomist was thus calmly demolishing the unfortunate Faujas, he himself, no less than the Campers, was the victim of a skilful imposture, which has only been recently discovered.

We have referred to certain supposed remains of the mosasaurus as having been purchased by Pierre Camper from the heirs of Hoffmann, the surgeon. These remains were forgeries! The pieces described by the two Campers, and by Cuvier himself, were mostly fabricated by

Hoffmann; as Schlegel, in the course of his studies of the mosasaurus, has discovered. His exposure of this singular fraud is contained in a letter addressed to Prince Charles Bonaparte, and by the latter communicated to the French Academy of Sciences.

SKULL OF THE MOSASAURUS.

The sagacity of Adrian Camper had detected that the ossicles of the extremities of the mosasaurus had been glued by Hoffmann to a block of chalk from the Maestricht quarries.

When Schlegel came to examine this block more closely, he not only perceived the truth of Camper's observation, but ascertained that the same artifice had been employed for a considerable number of other pieces described by Camper, and, after him, by Cuvier. Hoffmann had not contented himself with excavating holes in the blocks of chalk, in filling them with plaster, and attaching to them the remains or fragments which he intended to sell; but had united into one several diverse bony pieces, and changed their apparent character by partly embedding them in the plaster, and by placing them one upon another.

VI. THE RHYNCHOSAURUS.

This member of the great saurian family was of small dimensions, but not, therefore, the less curious or interesting in its structure and organization.

Its skull, considered as a whole, was more akin to that of the bird or the tortoise, than that of the lizard.

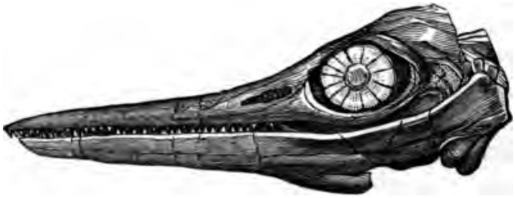
In fact, the intermaxillary bones, which are very long, curve downwards, so that, when looked at in profile, the fore part of the skull reminds one of a parroquet's beak.

There are no apparent teeth in the upper jaw, but only insignificant notches.

Professor Owen is of opinion that the jaws of this reptile were enclosed in a bony tube. Its name indicates one of its characteristics: the "beaked lizard," or "lizard with a beak."

VII. THE ICHTHYOSAURUS.

The *Ichthyosaurus* (*ἰχθὺς*, *fish*, and *σαῦρος*, *lizard*) has been so named by Sir Everard Home to express the relations of this reptile to both the fishes and the saurians. But its relations are much more manifold than this name would lead the reader to suppose.



HEAD OF THE ICHTHYOSAURUS.

It had the skull of a lizard, the narrow snout of a dolphin, (and Bayle thinks that, like the latter, it was provided with vent-holes,) the pointed conical teeth of the crocodile, eyes whose sclerotica* was strengthened by a framework of bony pieces,—an arrangement met with only in birds, tortoises, and lizards,—the vertebrae of fishes and cetaceans, flat, and biconcave on their two faces; a sternum and shoulder-bones like to those of lizards and ornithorhynci; fins analogous to those of cetaceans, made in one piece, nearly without inflections, but four in number.

---

* The hard membrane over the eyes.

M. Pouchet writes that in its appearance it must have recalled the porpoises; and, according to him, the animal forms a class apart between the reptiles and the amphibia.

Like the cetaceans, the ichthyosauri were animals essentially marine in their habits; carnivorous, like the majority of the former, with an aerial respiration like theirs; gifted, like them, with the faculty of remaining a long time under water; able, like them, to cleave the deep with rapidity.

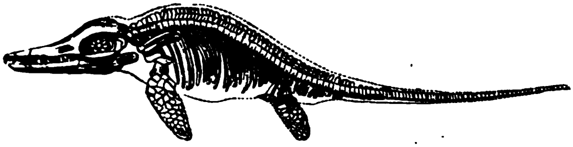
Their limbs, like the limbs of cetaceans, were fit only for natation.

It is probable, says Cuvier, that the ichthyosaurus could not crawl along the shore so well as the seals, but must have remained there immovable, like the whale or the dolphin, if once wrecked upon it. Its dimensions are another feature of resemblance to the cetaceans: some of them must doubtlessly have measured upwards of thirty feet in length.

Bayle designates the ichthyosaurus as "the whale of the saurians," "the cetacean of the primitive seas." And there can be no doubt that it discharged in the seas of the Jurassic period the same functions as the cetaceans now discharge.

Ichthyosauri abound in the Oolitic formations of the secondary series. They have been discovered in immense quantities in the Lias of Lyme-Regis.

The skull was voluminous; the neck short and thick; the number of vertebrae in certain species exceeded one hundred. Their form, their disposition, and their flexibility enabled them to move with the greatest swiftness.



SKELETON OF AN ICHTHYOSAURUS.

The flanks, which extend the whole length of the vertebral column, seem to indicate that the lungs, being very extensive, were able to admit a very great quantity of air, a circumstance which permitted the ichthyosaurus to remain a long time under water.

Its four limbs were actual fins, the anterior being about one-half larger than the other; the bones of the limbs are much more numerous and compact than those of the cetaceans. Those of the anterior fins, disposed in six rows, sometimes exceed one hundred. The bones of the arm are not very long, and those of the fore-arm are so reduced that they can scarcely be distinguished from phalanges. All these conditions, taken together, converted the extremities of the ichthyosaurus into oars of an incomparable power. Its rapidity of movement was greatly assisted by a tail of moderate size, composed of eighty to eighty-five vertebrae, and provided with stout fins, placed (and this is remarkable) not horizontally, like those of the cetaceans, which, by this single characteristic, is distinguished from the fishes, but vertically, as in the latter. In the skeletons of the ichthyosaurus it is to be remarked that the caudal vertebrae are abruptly curved, or rather dislocated towards about one one-third of the tail, and always in the same direction. Professor Owen has conjectured that this fracture was produced by the weight of the broad and fleshy fin.

Their eyes were of a prodigious size. In a skull which Dr. Buckland studied, the orbitary cavity was fourteen inches in diameter. But we can appreciate more directly the exceptional magnitude of the organ of sight. The sclerotica was reinforced by a circle of bony pieces which are admirably preserved in certain skulls. This circle permits us to measure the size of the eye as exactly as if we had the eye itself before us. Now, in certain species it was as large as a man's head.

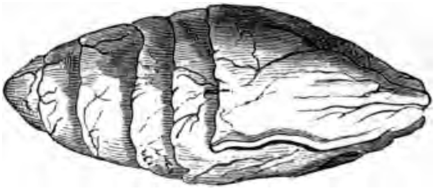
This extraordinary development is an undeniable proof that the organ of sight was endowed with an extraordinary perfection. As for the corneous circle of which we have just spoken, and which surrounded the opening of the pupil serving to carry the transparent cornea in front or behind, and consequently to vary its curvature at the pleasure of the animal, it was evidently a means of adapting the sight to certain distances; it therefore enabled the ichthyosaurus to see equally well an object close to it or far from it. And, besides, it protected the enormous ocular globe sometimes against the shock of the waves, sometimes against the pressure of deep waters.

The ichthyosaurus was equally well organized for seizing its prey. The jaws, in certain species, were seven feet long; they were armed with numerous teeth, sometimes with as many as one hundred and twenty. From the shape of these teeth we may infer that the animal, like the crocodile, swallowed its prey without masticating it. Their stomach formed a pouch of prodigious size; the proof is the dimension of the fish which have been found among the skeletons of numerous ichthyosauri, and were evidently the remains of their last repasts. From these *débris* we have also been able to ascertain that the ichthyosauri devoured one another. In exact opposition to the stomach, the intestines occupied but little space, though they offered a great absorbent surface, being disposed in a spiral like those of the sharks and rays.

Not, indeed, that these organs have been handed down to the scientific investigation of our comparative anatomists; but, in an indirect manner, we have learned their true structure as certainly as if we ourselves had examined them. We have not the intestines, but we have the *mould* of their interior.

Over an area of several thousand yards in length, in our English Lias formations, we find an abundant quantity of different kinds of oblong pebbles, ordinarily from two to four inches in length, by one to two in diameter; they are seldom found much larger. They are as plentiful as potatoes in a potato field.

These apparent pebbles are the petrified excrements of the ichthyosaurus; they are frequently met with in the abdominal cavity of these animals, and have received the distinctive name of *Coprolites*. Now, these coprolites, by their composition, acquaint us with the nature of the food on which the Ichthyosauri lived, just as by their configuration they reveal the disposition of the intestines of these animals.



A COPROLITE.

The outline of these excrements shows us, as Buckland observes, that they have been moulded like a blade or plate, flattened, and twisted in a spiral from the centre to the circumference, as is seen in a turbinate shell. On the exterior you can recognize the slightest wrinkles and impressions they received while lying in a plastic condition in the intestines of the living animal.

These petrifactions contain an abundance of scales, teeth, and bones, scattered irregularly in their interior. The hard and brilliant scales are those of fish which swarm themselves in the Lias. The bones are mainly the vertebrae of fishes and young ichthyosauri.*

The first notice of the ichthyosaurus occurs in the works of Scheuchzer. One day, while he was walking near the gallows of Altorf, one of his friends, who had penetrated into the inclosure, threw to him over the walls a block of stone containing several vertebrae of one of these animals. Scheuchzer supposed them to belong to the human species, and engraved them in his *Piscium Querelae.* Several *savants* adopted his opinion.

---

* "When we discover in the body of an ichthyosaurus the food which it has engulfed an instant before its death, when the intervals between its sides present themselves still filled with the remains of fishes which it had swallowed some ten thousand years ago, or a time even twice as great, all these immense intervals vanish—time disappears—and we find ourselves, so thrown into immediate contact with events which took place in epochs immeasurably distant, as if we occupied ourselves with the affairs of the previous day."

The first truly scientific description is due to Sir Everard Home, who, in 1814, published some observations on a head well preserved, and on various bones found in the Lias of Lyme-Regis. The position of the nostrils, the osseous pieces surrounding the sclerotica, and the form of the biconcave vertebrae which had already been figured by Lloyd under the name of *Ichthyospondylus*, seemed indications, to Sir Everard Home, of its close affinity to fishes. König, curator of the Mineralogical Museum, proposed for it the name of *Ichthyosaurus.*

Some new remains, discovered, in 1816 and 1818, in the same locality, upset this original conclusion; and in 1819 an entire skeleton, exhumed by De la Bêche and Birch, enabled our anatomists to establish the fact that the animal was provided with four limbs. The nostrils, by which our scientific authorities thought to have determined the animal's place in the first specimens, were found completely obstructed and unrecognizable in the latter. They therefore concluded themselves to have been mistaken; and Sir Everard Home, in consequence of certain resemblances which he detected to the proteus and the siren, suggested the name of *Proteosaurus*, and substituted it for the preceding.

In 1821, De la Bêche and Conybeare, having resumed the study of this animal, demonstrated that the ring of osseous pieces of the sclerotica was a characteristic of lizards, and not of fishes. Two years later they re-established the true position of the nostrils; and, finally, they brought out clearly the relations and differences of the head as compared with that of a lizard. By a careful examination of the teeth, they succeeded in distinguishing four species of ichthyosauri :—

1. *Ichthyosaurus communis*, the largest of all, whose teeth are slightly sharpened, somewhat arched, deeply striated, and with a conical crown;

2. *Ichthyosaurus platyodon*, whose teeth have a compressed crown, with keen ridges;

3. *Ichthyosaurus tenuirostris*, with weak teeth, and long thin muzzle; and,

4. *Ichthyosaurus intermedius*, with sharper but less striated teeth than those of the *Ichthyosaurus communis*.

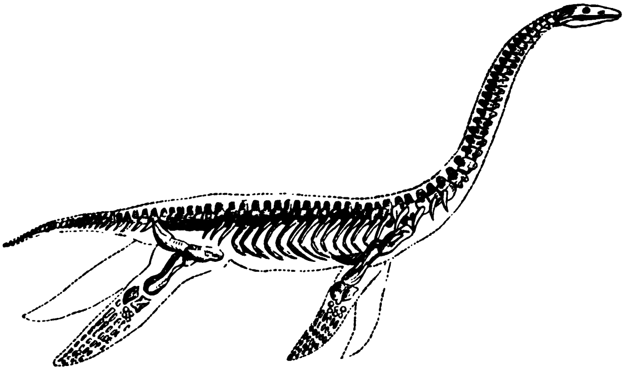
VIII. THE PLESIOSAURUS.

The *Plesiosaurus* is so named from the Greek πλησίος, *near to*, and σαῦρος, *a lizard.*

Its head bore a close resemblance to a lizard's; it had the teeth of a crocodile; a swan's neck, but less extensive plumes; the trunk and tail of quadrupeds; the sides of a chameleon; and the fins of a whale.

It has been inferred that the plesiosaurus (which Conybeare discovered) must, in appearance, have been more monstrous even than the ichthyosaurus—more monstrous, that is, according to the human ideal of beauty. For though it cannot be said that the structure and organization of any one animal is inferior in exquisiteness of workmanship, and ingenious adaptation of means to an end, to those of any other animal, it is undoubtedly true that it may be far less pleasing to the eye. The bird of paradise is more attractive than the horned owl, the butterfly than the spider.

The limbs of the plesiosaurus were somewhat longer and more flexible than those of the ichthyosaurus; its shoulder and pelvis were more robust; its vertebrae approached more nearly in form and articulation to those of lizards. But what particularly distinguished it from oviparous and viviparous quadrupeds was its long neck, a neck as long as its body, composed of thirty and more vertebrae—a larger number than is found in the neck of any other animal—raised upon the trunk like an erect serpent, and terminating in a very small head, which possessed all the essential characters of a lizard's.



SKELETON OF A PLESIOSAURUS.

If anything could justify the hydras and those other monsters whose laidly figures are so frequently repeated on the mediaeval monuments, it would incontestably be the plesiosaurus.

Cuvier affirms that, in the aggregate, its characters are the most monstrous that have been met with among the races of the primeval world.

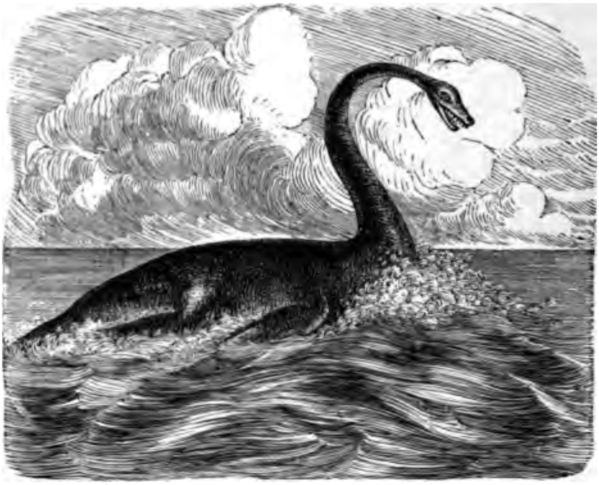
It was a contemporary of the ichthyosaurus, and, like it, a carnivore; both have been found in the Lias of Lyme-Regis.

The plesiosaurus exceeded thirty feet in length.

According to Conybeare, it was an aquatic animal; this is clearly shown by the structure of its feet. It was "a tenant of the waves;" the remains constantly found accompanying it are no less conclusive on this point. The similarity of its extremities to those of tortoises would lead us to infer that, like the latter, it came occasionally to the shore; but its movements upon terra firma must have been wholly wanting in agility, and the length of its neck was an obstacle to its rapid progression in the water; in this contrasting remarkably with the ichthyosaurus, which was so admirably organized to cleave the waves.

And as to these various circumstances it joined, as a necessary consequence of its mode of respiration, an indispensable frequency of communication with the atmosphere, may we not conclude that it swam on the very surface of the waters, or floated like a swan, occasionally arching its long and flexible neck, occasionally darting it downward to seize the fish which were within its range?

It may be, too, that it kept very near the shore, in shallow waters, concealed among marine plants, and, by means of its long neck, keeping its nostrils above the surface of the waves; thus securing a safe retreat from the attacks of its most dangerous enemies. On the other hand, this length and flexibility of neck, through the promptitude and suddenness of the attack they enabled the animal to deliver against whatever object swept within its reach, compensated it for the feebleness of its jaws, and the impossibility of rapid progression in the bosom of the seas.



THE PLESIOSAURUS, RESTORED.

As already stated, its most extraordinary character is the extreme length of its neck, which was nearly equal to all the rest of its body. The trunk was rounded as in the great marine tortoises, which tempts one to say that the plesiosaurus might be compared to a serpent half concealed in a turtle's carapace. However, no trace of carapace, or even of scales, has hitherto been detected. The short extremities, formed of numerous bones, were composed, as in the whales, of five series of elongated phalanges, representing the five fingers. The tail, proportionally very short, was not at all like that of a reptile; it performed the office of a rudder. The vertebrae were ninety in number: thirty-five cervical, twenty-seven dorsal, twenty-six caudal, and two *os sacrum;* their body is barely concave. The sides were formed of two portions; one vertebral, and the other ventral. The two sides were bound together by an intermediary bone; a structure analogous, as Cuvier remarks, to that of the chameleons, and also of some iguanas.

Hence Cuvier concluded that the lungs must have been of considerable volume, and that perhaps, if the skin of the plesiosaurus was not scaly, its colouring was subject to changes in harmony with the variable intensity of the respiration.

We have no means, says Buckland, of verifying this ingenious conjecture, which represents the plesiosaurus as a kind of marine chameleon; but we may admit that the faculty of varying the colour of its integuments would have been a great advantage to it, by furnishing it with the means of concealing itself more completely from the sight of the ichthyosaurus, its most formidable enemy. Against this adversary, a combat with equal arms was impossible, on account of the smallness of its head and the length of its neck; and the feebleness of its means of locomotion would likewise render flight impossible.

The plesiosaurus was described by Conybeare in 1821, in a memoir inserted in the "Philosophical Transactions." Three years later, a complete skeleton was discovered at Lyme-Regis. Conybeare christened it *Plesiosaurus dolichodeirus.* A specimen, eleven feet long, is preserved in the British Museum.

Numerous species have been found distributed among the various secondary formations.

Professor Owen characterizes the plesiosaurus as an air-breathing and a cold-blooded animal. He points out, as a proof that it respired atmospheric air immediately, the position and structure of the nasal passages, and the bony mechanism of the abdominal cavity and thoracic duct. In the first, the size and place of the outer nostrils, combined with the structure of the feet or paddles, indicate a remarkable analogy between the extinct saurians and the cetaceans, and present a fine example of the adaptation of structure to the exigencies of species. The flexible condition of the osseous pieces of the occiput, and other cranial bones of the lower jaw, as well as of the vertebral column, may be held to prove that the plesiosaurus was cold-blooded, and that the heart was capable of transmitting a part only of the blood through the respiratory organs.

The same learned anatomist has created the genus *Pliosaurus* as an intermediary between the ichthyosaurus and plesiosaurus. It belongs to the Oxford and the Kimmeridge clays.

IX. THE PTERODACTYL.

The *Pterodactyl* was qualified, says Dr. Buckland, like Milton's fiend, for all services and all elements; the creature was a fit companion for the kindred reptiles that swarmed in the seas or crawled on the shores of a turbulent planet:—

"The fiend
O'er bog or steep, through strait, rough, dense, or rare,
With head, hands, wings, or feet, pursues his way,
And sinks, or swims, or wades, or creeps, or flies."

With flocks of such singular creatures flying in the air, and shoals of ichthyosauri and plesiosauri swarming in the ocean, and gigantic crocodiles and tortoises crawling on the shores of primeval seas, lakes, and rivers; air, land, and sea must have been strangely tenanted in those infant days of our land.*

The pterodactyl derives its name from πτερόν, *a wing*, and δάκτυλος, *a finger*. It was so called by Cuvier, because at each of its anterior extremities an excessively elongated claw or finger carried a membrane adapted to support the animal in the air.

Shortly speaking, it was a kind of flying lizard.

In the length of its neck and the shape of its head it resembled a bird;

In its trunk and its tail, an ordinary mammal;

In its numerous and pointed teeth, a reptile;

In its wings, a bat.

Some of these strange animals, which would appear to our unaccustomed eyes so terrible, were probably of the size of a bat; others, of the ordinary thrush; but others would seem to have been of far larger dimensions, and not inferior to the modern cormorant. A species must have existed whose sweep of wings was fully twenty feet, if it be true that the remains of the animal described by

---

* Dr. Buckland, Bridgewater Treatise.

Owen under the name of the *Cimoliornis* did not belong to a bird, as Owen, Cuvier, and Dr. Mantell supposed, but, as Bowerbank suggests, to a pterodactyl.

It is found in the Jurassic strata. In the Lias of Lyme-Regis the bones are found mixed with those of the ichthyosaurus and plesiosaurus.

THE PTERODACTYL, RESTORED.

The most striking peculiarity of this singular animal is, as Cuvier says, the union of vigorous wings with a reptile's body; the like has never been figured except in the imagination of the poets. And it is not improbable that its remains, or some late-lingering individual, may have suggested the description of those dragons which figure in the old mythology, and which are represented as having disputed, in the early history of the world, the possession of the Earth with primeval man. Their destruction is always painted as the most heroic achievement of the heroes of fable, of its gods, and demi-gods.

At the present day there exists but a single reptile furnished with wings,—the lizard-dragon of the island of Java; but these modern dragons, in their diminutive proportions, cannot be compared to the pterodactyl of the ancient world. Their wings, too weak to strike the air and maintain them, like birds in flying, served but to support them like a parachute in leaping from branch to branch. The pterodactyl flew by the aid of wings supported principally upon a very long finger, while the other fingers preserved their ordinary dimensions; hence the name of this fantastic animal.

Bory de St. Vincent says on this subject:—

"The figure of the pterodactyl seems to represent with sufficient exactness the figure which antiquity gave to those formidable dragons we now regard as fabulous. Yet they may not impossibly have existed towards the epoch of the period immediately preceding the so-called pre-historic; an epoch of which so many extraordinary remains exist. It may even be that dragons of this kind, pterodactyls far larger than those which have recently been discovered, lingered until the time when man appeared upon the earth—until the epoch when he began to carve upon wood and stone the most striking objects around him. When the models had disappeared—when their memory was preserved only in the hieroglyphics of tribes who knew not how to write, though knowing how to carve—this memory became mythological. To the image of the lost dragon some fantastic features were added; so disguising it, that it could not be recognized if ever any remains were discovered. The imagination went so far as even to amalgamate the idea with that of the destructive volcanoes, filling their jaws with flames. The history of the dragons, or the exaggerated pterodactyls, ceases to belong to the history of Nature, to sink into that of fable and the theogonies."

The fingers of the anterior limbs are of the ordinary dimensions, and terminated by crooked nails. Cuvier conjectures that the animal made use of them to suspend itself to the branches of the trees. In a state of repose it must have rested on its hind-limbs like a bird; like a bird, too, it must have held up its neck curving behind, so that its enormous head should not disturb its equilibrium.

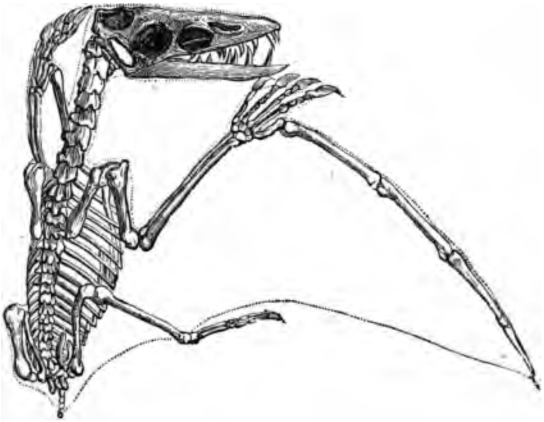
Dr. Buckland remarks that the size and form of the feet, of the leg and the thigh, prove that these animals could hold themselves erect with firmness, their wings folded, and thus move forward in a manner analogous to that of birds. Like them, too, they could perch upon the trees, while they had the faculty of crawling along the rocks and cliffs, with the assistance of their hands and feet, as bats and lizards do at the present day.

Undoubtedly they were insectivorous, and perhaps nocturnal. In the quarries of Solenhofen they are found associated with great fossil dragon-flies; and in the Oolitic limestone of Stonesfield, near Oxford, with the scales of coleoptera.

Carus is of opinion that their skin was covered, not with scales, but with very thin corneous expansions or tolerably thick hair.

Their mixed organization amply explains the diversity of opinions to which they have given rise.

Collini, director of the cabinet of Mannheim, was the first to describe them. He also figured them, after a certain fashion, in 1783, in the *Mémoires* of the *Académie Palatine.* Not being well acquainted with anatomy, he mistook them for the remains of fishes.



SKELETON OF THE PTERODACTYL.

At a later date, Bermann of Strasburg treated of them as mammals, and represented them as such, the body wholly covered with hair.

Cuvier, who studied them in 1800, ranked them among reptiles; and his opinion was adopted by Oken and Dr. Buckland.

Blumenbach, on the contrary, considered them to be swimming birds (*natatores*). Soon afterwards, Soemmering, in his turn, classed them among the mammals.

At a later date, Wagner made them the type of a special class, that of the *Ornithocephali*, which, according to him, differed in some important characters from all animals now living: he placed them between the mammals and the birds. Blainville also erected them into a class, but placed this class between the birds and the reptiles.

In the same way they are described by Pouchet as a separate and distinct class. When you study the skeleton of the pterodactyl, he says, you adopt the views of those naturalists who have constituted them a distinct class. In fact, these animals, by the smallness of their skull, are set too far apart from the mammals to be comprised in the same group; and the form of the head has no relation to that of the bats, near which some authorities have attempted to place them.

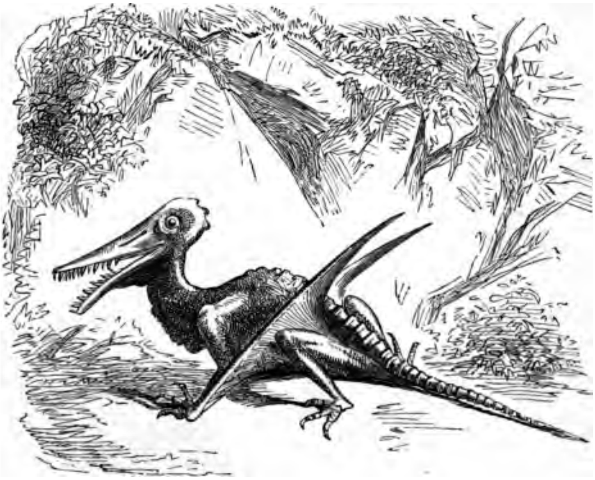
It is impossible with any justice to refer the pterodactyls to the birds: in fact, they differ from the latter in the teeth with which their maxillaries are provided; in their cervical vertebrae, which are less numerous than in any animal of this class; also by their flanks, which, far from being broad, are frail and filiform: they are also separated from birds by the structure of their wings, which are formed of a single finger, and which, instead of presenting only three articulations above the fore-arm as in them, number no fewer than five: finally, they are also distinguished from these animals by their metatarsus, which is composed of several bones.

The singular beings we are describing are also markedly distinct from reptiles by the elongation of their head, as well as by the dimensions of their hind-limbs, which are such, that in no reptile are they found of similar length, proportionally.

Soemmering, in combating the opinion of Cuvier, has pointed out that the smallness of their tail was a great argument against the assertion of the celebrated anatomist, who looked upon the pterodactyls as analogues of the saurians.

X. THE RAMPHORYNCHUS.

We have here another winged saurian. It is closely akin to the pterodactyl. Its long tail is its distinctive characteristic; that of the pterodactyl is only rudimentary.

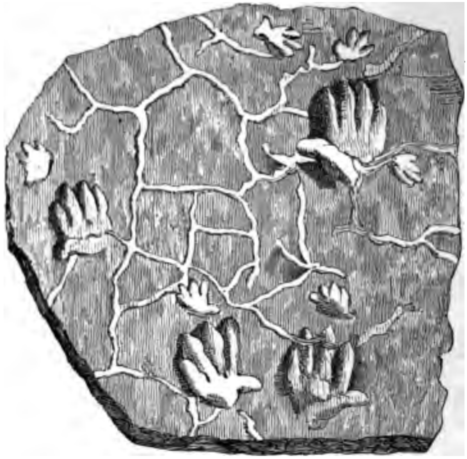


THE RAMPHORYNCHUS, RESTORED.

It was about the size of a crow. In the Oolitic strata may be seen the double impress of its three-toed feet, and of the tail which it dragged behind it. Mr. Waterhouse Hawkins has constructed for the Crystal Palace a model of this animal, from which the accompanying illustration is taken.

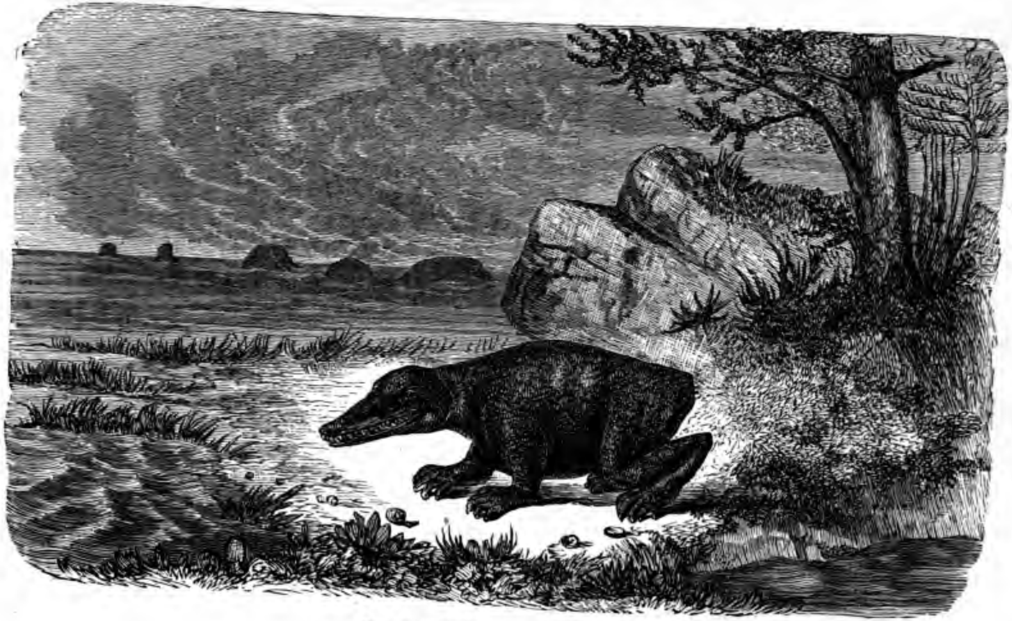
XI. THE CHEIROTHERIUM, OR LABYRINTHODON.

In the *Variegated Sandstone*, or Bunter, of Germany, near Hildburghausen, a naturalist named Kaup found, in 1835, the traces of the feet of a quadruped, and, on account of their resemblance to the impressions of a hand, he designated the unknown animal which had produced them, the *Cheirotherium* or *Cheirothere*.



IMPRINTS OF THE FOOT OF THE CHEIROTHERIUM.

Impressions exactly similar have since been discovered



THE CHEIROTHERIUM, RESTORED.

in a multitude of localities, both in the Variegated Sandstone and the Muschelkalk.

The French geologist Daubrée, for instance, exploring at Saint-Valberd, in the department of la Meurthe, a quarry where the Variegated Sandstone was being worked, has ascertained their existence at the very limit of thin strata of sandstone and clay which alternate beneath the great red blocks. Just as at Hildburghausen, the foot has made an impression at first in the clay, and the relief which the stratum of sandstone presents on the lower face is only the counter-proof of the direct impressions. Side by side with these great feet we find, moreover, an innumerable quantity of little feet, proceeding in various directions; each foot having four toes only, and closely resembling the foot of a frog.

A circumstance which largely enhances the interest of these vestiges is, that the mud on which the animal walked was sufficiently plastic, not alone to receive and preserve the exact form of the feet and their nails, but also to seize the inequalities of the skin with as much delicacy as a skilful moulder could; these latter peculiarities are reproduced even in the counter-impression. Each fore-foot and hind-foot exhibits in all its parts, on the sole as on the toes, a granulation which is incontestably of organic origin. The surface of the soil presents nothing like this elsewhere. The granulation is very regular, except on certain oblique bulges, where the animal's slipping foot has produced a slight friction; these are tiny rounded protuberances, the greatest of which do not measure a millimètre in diameter.

Kaup concluded that these impressions were the impressions of a mammal; but a certain number of bones having since been discovered (the head, the pelvis, and a part of the omoplate), Professor Owen has laid it down as a fact that the cheirothere was not a mammal, but a gigantic batrachian.

Its jaws were filled with very strong conical teeth, of a complicated structure; and it is this maze-like or labyrinthine structure which has procured the animal the name of *Labyrinthodon.* It is supposed that its head was prolonged by an osseous buckler.

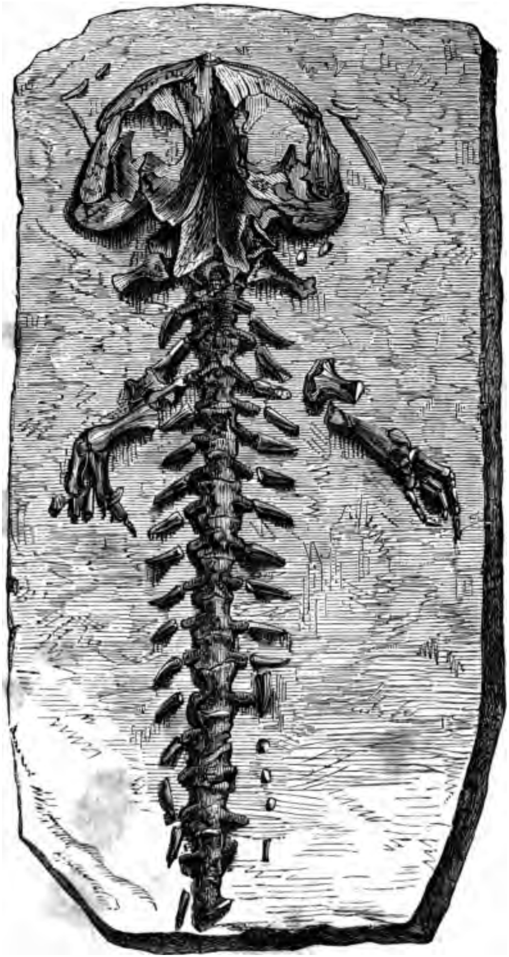
XII. THE ANDRIAS.

The *Andrias* was a salamander—not a mythic, but a real one. Our modern salamanders, however, are but a decimètre in length; the andrias was a mètre and a half.

It was taken at first for a man. "Can it be possible," says Pierre Camper, "that a petrified lizard was ever supposed to be a man?" Possible! certainly; for the mistake was made, and made by a Swiss physician, a naturalist, Jean Jacob Scheuchzer.

We must not estimate his abilities and acquirements by this error. Scheuchzer, as M. d'Archiac reminds us, was an indefatigable worker, devoted to science, a man well-informed, and, in many respects, in advance of his age.

It was in 1725, in the schistous limestone of Oeningen, not far from Constance, that a skeleton, marvellously preserved and closely embedded in the rock, was exhumed, and supposed by Scheuchzer to be the remains of a man who had witnessed the awful catastrophe of the



THE ANDRIAS, OR GREAT SALAMANDER OF OENINGEN.

Noachian Deluge. *Homo diluvii testis:* such was the title of the dissertation on this subject which he published in 1731. An illustration of the mysterious fossil accompanied his laborious letterpress.

It is certain, says the author, that this schist contains a half, or nearly so, of a human skeleton; that the very substance of the bones, and, which is more, of the flesh, and of parts softer than the flesh, are incorporated in the stone;—in a word, that it is one of the rarest relics we have of the accursed race which was buried under the waters. The illustration shows us the outline of the frontal bone, the orbits, with the openings through which the great nerves of the fifth pair passed. The remains may also be seen of the brain, the sphenoid, the root of the nose, and a notable fragment of the maxillary bone.

The contemporaries of the Swiss naturalist were of the same opinion, with the exception of Pierre Camper. He went to Oeningen; he examined the fossil; and it was then he cried, "Is it possible to mistake for a man a petrified lizard?"

Yet Camper himself was in the wrong. The fossil was not a lizard, but a salamander. That such was the case, the genius of Cuvier discovered from a single inspection of the illustration.

"Take," he said, "a skeleton of a salamander, and place it beside the fossil, without allowing your judgment to be led astray by difference of size, as might easily happen in comparing a drawing of a salamander on the same scale as in nature with the drawing of the fossil reduced to one-sixth of its proper proportions, and everything will be explained in the clearest possible manner.

"I am even persuaded that, if we could dispose of the fossil, and seek in it a few more details, we should find still more numerous proofs in the articular faces of the vertebrae, in those of the jaw, in the vestiges of the smallest teeth, and even in parts of the labyrinth of the ear."

Some time afterwards, Cuvier, being at Haarlem, put his conjectures to the test; and when the chisel had discovered the bones concealed under the stone, lo, he found the eyes, not of an Antediluvian man, nor even of a lizard, but of a salamander, as he had predicted.

BOOK IV.—FISHES.

> “See, through this air, this ocean, and this earth,
> All matter quick, and bursting into birth:
> Above, how high progressive life may go;
> Around, how wide; how deep extend below.
> Vast chain of being, which from God began,—
> Nature's ethereal, human angel, man,—
> Beast, bird, fish, insect, what no eye can see,
> No glass can reach,—from Infinite to Thee,
> From Thee to nothing. On superior powers
> Were we to press, inferior might on ours,
> Or in the full creation leave a void,
> Where, one step broken, the great scale's destroyed:
> From Nature's chain whatever link you strike,
> Tenth or ten thousandth, breaks the chain alike.”
>
> POPE.

AGASSIZ, who has described upwards of two thousand species of fossil fishes, values at twenty-five thousand the total number of those which lie buried, in a more or less perfect state, in the strata of the earth.

Living nature does not contain above eight thousand.

Scales being, of all parts of the fish, those which are most frequently found, it is upon these organs that Agassiz has based his classification. He divides fossil fishes into four orders, characterized by the form of the scales.

These are: the Placoïd, the Ganoïd, the Cycloïd, and the Ctenoïd.

The skin of the *Placoïds* is sometimes irregularly covered with plates of enamel occasionally very large, and sometimes encrusted with small osseous bodies, which render it hard and rough to the touch. Their skeleton is cartilaginous. This order corresponds in most particulars with that of the cartilaginous fishes of Cuvier.

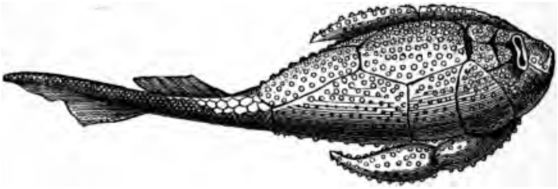
The *Ganoïds* are encased in a kind of cuirass or carapace. Their scales—broad, solid plates, composed of a bony layer coated with ivory, and resembling consequently the structure of the teeth—instead of overlapping each other, are placed side by side like paving-stones. Their skeleton is chiefly osseous, yet less so than in the *Cycloïds* and *Ctenoïds*. The vertebral column does not end where the caudal fin commences, but is continued beyond that point, forming a tail, to which the fin is attached, something like the rudder to a boat.

The Placoïds and Ganoïds are the most ancient of all fishes; the former have lived through every period of the world's history. They are nowadays represented by the sharks and rays. The latter fell into decay at the close of the Jurassic epoch, and have now but few representatives, such as the lepidosteus, the polyptera, the sturgeon, and the like.

While these two orders include the most ancient fishes, they also include those whose forms most widely depart from living nature.

Let us take, for instance, the *Pterichthys*, and the

Cephalaspis, genera of the family of the Cephalaspids, which belong to the order of the Ganoïds. Agassiz says of this family that "it constitutes a type as clearly defined in the series of fishes as the ichthyosauri and the plesiosauri among the reptiles." Few fossils have given rise to more opposite opinions than the pterichthys has done. It has been referred even to the family of *Trilobites*, which are crustaceans, and to the class of insects.



THE PTERICHTHYS, VIEW OF THE UNDER PART.

The first known specimen of the pterichthys was discovered in the Old Red Sandstone by Hugh Miller, who describes it in graphic language :—

> Imagine, he says, the figure of a man rudely drawn in black on a gray ground; the head cut off by the shoulders; the arms spread at full, as in the attitude of swimming; the body rather long than otherwise, and narrowing from the chest downwards; one of the legs cut away at the hip-joint, and the other, as if to preserve the balance, placed directly under the centre of the figure, which it seems to support. Such, at a first glance, is the appearance of the fossil. The body was of very considerable depth—perhaps little less deep proportionally from back to breast than the body of the tortoise; the under part was flat; the upper rose towards the centre into a roof-like ridge; and both under and upper were covered with a strong armour of bony plates, which, resembling more the plates of the tortoise than those of the crustacean, received their accessions of growth at the edges or sutures.

The plates on the under side are divided by two lines of suture, which run, the one longitudinally through the centre of the body, the other transversely, also through the centre; and they would cut one another at right angles, were there not a lozenge-shaped plate inserted at the point where they would otherwise meet. There are thus five plates on the lower or belly part of the animal. They are all thickly tubercled outside with warlike prominences; the inner present appearances indicative of a bony structure. The plates on the upper side are more numerous and difficult to describe, just as it would be difficult to describe the forms of the various stones which compose the ribbed and pointed roof of a Gothic cathedral—the arched ridge or hump of the back requiring, in a somewhat similar way, a peculiar form and arrangement of plates.

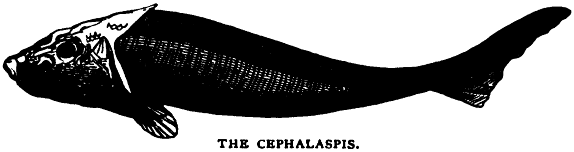
The apex of the ridge is covered by a strong hexagonal plate, fitted upon it like a cap or helmet, and which nearly corresponds in place to the flat central plate of the under side. There runs around it a border of variously-formed plates, that diminish in size and increase in number towards the head, and which are separated, like the pieces of a dissected map, by deep sutures. They all present the tubercled surface.

The eyes are placed in front, on a prominence considerably lower than the roof-like ridge of the back; the mouth seems to have opened, as in many fishes, in the edge of the creature's snout, where a line running along the back would bisect a line running along the belly. The two arms or paddles are placed so far forward as to give the body a disproportionate and decapitated appearance. From the shoulder to the elbow, if these terms may be employed, there is a swelling muscular appearance, as in the human arm; the part below is flattened so as to resemble the blade of an oar, and terminates in a strong sharp point. The tail—the one leg on which the creature seems to stand—is of considerable length—more than equal to a third of the entire figure—and of an angular form, the base representing the part attached to the body, and the apex its termination. It was covered with small tubercled rhomboidal plates, like scales; and where the internal structure is shown, there are appearances of a vertebral column, with rib-like processes standing out at a sharp angle.

Such is a brief sketch of a creature whose very type seems no longer to exist.*

The *Cephalaspis* is found in the central or cornstone division of the Old Red Sandstone in England. Several species have been determined, as, the Cephalaspis Lewisii, Cephalaspis Lloydii, Cephalaspis Lyellii, Cephalaspis rostratus, Cephalaspis Sauvagii, and Cephalaspis Murchisoni. The first two species, however, according to Professor Huxley, are *Pteraspides.*

In general outline the cephalaspis has been compared to a saddler's cutting-knife—a tool with a crescent-shaped blade, and the handle fixed transversely in the centre of its concave side. In the fish the head resembled the crescent-shaped blade, and the body its transverse handle. We have but to give the handle, says our authority, an angular instead of a rounded shape, and to press together the pointed horns of the crescent till they incline towards each other, and the convex or sharpened edge is elongated into a semi-ellipse cut in the line of its shortest diameter, in order to produce the complete form of the cephalaspis.



THE CEPHALASPIS.

The head must have been of great size, compared with the body: it comprised fully one-third of the creature's entire length. In the centre, and placed closely together, as in many of the flat fishes, were the eyes.

---

* Miller, "The Old Red Sandstone," pp. 74, 75.

Some of the specimens, says Hugh Miller, show two dorsals, and an anal and a caudal fin. The thin and angular body presents a jointed appearance, somewhat like that of a lobster or trilobite. Like the bodies of most of the ichthyolites of the system, it was covered with variously-formed scales of bones; the creature's head was cased in strong plates of the same material, the whole upper side lying under one huge buckler; and bears the name *Cephalaspis*, or buckler-head. It seems to have been amply provided with defensive weapons, in proportion to its size and strength. So massive was its covering, that its remains are found comparatively entire in arenaceous rocks impregnated with iron, in which few other fossils could have survived. Its various species, according to Sir Roderick Murchison, seem not to have been suddenly killed and entombed, but to have been long exposed to submarine agencies, such as the attacks of animals, currents, concretionary action, and so on; yet, though much dismembered, the geologist has little difficulty in recognizing even the smallest portions of them.

It seems to have been not less amply provided with offensive than defensive weapons. The sword-fish, with its strong and pointed spear, has perforated the oaken ribs of the firmest built vessels; and, poised and directed by its lesser fins, and impelled by its powerful tail, it may be regarded either as an arrow or javelin flung with tremendous force, or as a knight speeding to the encounter with his lance in rest. Now there are missiles employed in Oriental warfare, which, as Miller remarks, instead of being pointed like the arrow or javelin, are edged somewhat like the crooked falchion or saddler's cutting-knife, and are capable of being cast with so much force, that they have been known to sever a horse's leg through the bone; and if the sword-fish may be properly compared to an arrow or javelin, the combative powers of the *cephalaspis* may be illustrated, it is probable, by a weapon of this kind—the head all around its elliptical margin presenting a sharp edge, like that of a cutting-knife or falchion. Its impetus, however, must have been comparatively *forcible*, for it was provided with a large and powerful tail. The bolt was not only carefully fashioned, but the bow was mighty which cast it. If strong in the attack, in defence it was not less formidable. The pointed horns of the crescent, says Agassiz, seem to have served a similar purpose with the spear-like wings of the *pterichthys;* the sole difference consisting in the circumstance that the spears of the one could be elevated or depressed at pleasure, whereas those of the other were ever fixed in the warlike attitude.*

Has the reader ever heard of the "griesly fisch" and the "laithlie flood," described by Gawin Douglas, the poet-bishop of Dunkeld, "who gave rude Scotland Virgil's page"? And in whose version, as Mr. Collins remarks,† there is considerable vigour as well as faithfulness.

Both fish and flood, says Hugh Miller, are the extravagances of a poet's dream. We may add that they are not altogether unworthy of the sombre imagination of Dante. He describes the flood as sweeping onward through a wilderness of bogs and quagmires, under banks

"Dark as rocks the whilk the sey upcast."

A stunted and leafless skeleton forest, such as you sometimes see in Doré's pictures, stretched around; and through the barren, unblooming trees

"The whistling wind blew many a bitter blast."

The whitened branches clashed and clattered; the "vile water" running overhead, and roaring like thunder, made a hideous turmoil; and, to increase the horrors of the scene, the grisly fish lifted up their heads above the spoom, and, as they passed, gave their shrieks and yells to the wind, deafening the ears of those who listened. They were both elves and fishes; and the longer the spectator's eye rested upon them, the more terrified his heart became.

---

* Miller, "Old Red Sandstone," pp. 149–151. It is now known that this cephalic shield was entirely an armament for defensive purposes.

† Rev. W. L. Collins, "Ancient Classics: Virgil," p. 6.

Hugh Miller, who, to the accurate observation of a geologist, added much of the "informing fancy" of a poet, sees in the grisly fish of Gawin's dream a resemblance to the fish of the primeval world. They were hardly less curious, he says. We find them surrounded, in the same manner as in the poem, by a wilderness of dead vegetation, and of rocks thrown up from the dark sea-depths. The footprints of the storm and the tempest are around and beneath them. Any one who turns to the graphic descriptions in the "Old Red Sandstone," and endeavours to reproduce before his mind's eye the "laidly figures" of the *coccosteus*, the *osteolepis*, the *dipterus*, the *diplopterus*, the *cheirolepis*, the *glyptolepis*, the *cheiracanthus*, the *holoptychius*, and the *megalichthys*, will, we think, be readily inclined to form the same conclusion. Of the extraordinary variety of forms, some hideous—that is, according to our modern ideas of beauty—all interesting, the following imperfect list of genera and species, discovered in the Old Red Sandstone formations alone, will give the reader a strikingly impressive notion :—[*]

Acanthodes pusillus.

Actinolepis tuberculatus.

Asterolepis Asmusii; A. apicalis; A. granulata; A. Hoeninghausii; A. Malcolmsoni; A. minor; A. ornata; A. speciosa.

Bothriolepis favosa; B. ornata.

---

[*] Agassiz, "Poissons Fossiles."

Byssacanthus arcuatus; B. crenulatus; B. laevis.

Cephalaspis Lewisii; C. Lloydii; C. Lyellii; C. rostratus; C. Salweyi; C. Murchisoni.

Cheiracanthus microlepidotus; C. minor; C. Murchisoni.

Cheirolepis Cummingiae; C. Trailii; C. Uragus.

Chelyophorus pustulatus; C. Verneuilii.

Cladodus simplex.

Climatius reticulatus.

Coccosteus cuspidatus; C. decipiens; C. maximus; C. oblongus.

Cosmacanthus Malcolmsoni.

Cricodus incurvus.

Ctenacanthus ornatus; C. serrulatus.

Ctenodus Keyserlingii; C. marginalis; C. parvulus; C. Worthii.

Ctenoptychius priscus.

Dendrodus latus; D. minor; D. sigmoides; D. strigatus; D. tenuistriatus.

Diplacanthus crassipinus; D. longispinus; D. striatulus; D. striatus.

Diplopterus affinis; D. borealis; D. macrocephalus.

Dipterus macrolepidotus.

Glyptolepis elegans; G. leptopterus; G. microlepidotus.

Glyptopomus minor.

Haplacanthus marginalis.

Holoptychius Andersoni; H. Flemingii; H. giganteus; H. Murchisoni; H. Nobilissimus; H. Omaliusii.

Homacanthus arcuatus.

Homothorax Flemingii.

Lamnodus biporcatus; L. hastatus; L. sulcatus.

Narcodes pustilifer.

Naulas sulcatus.

Odontacanthus crenatus; O. heterodon.

Onchus heterogyrus; O. semistriatus; O. sublaevis.

Osteolepis arenatus; O. macrolepidotus; O. major; O. microlepidotus.

Parexus recurvus.

Phyllolepis concentricus.

Placothorax paradoxus.

Platygnathus Jamesoni; P. paucidens.

Polyphractus platycephalus.

Psammosteus arenatus; P. maeandrinus; P. paradoxus; P. undulatus.

Pterichthys arenatus; P. cancriformis; P. cornutus; P. major; P. Milleri; P. latus; P. oblongus; P. productus; P. testudinarius; P. Andersoni; P. hydrophilus.

Ptychacanthus dubius.

We see, then, that the fishes of the Primeval World differ in most particulars from those of living nature. Yet, as Agassiz and Heckel have shown us, they present many most curious points of resemblance to the embryos of the latter.

For example: in living fishes the tail is placed symmetrically at the extremity of the vertebral column; a peculiarity which Agassiz describes by the word *homocercal.* But, in some of these fishes, the tail in the embryo is placed *un*-symmetrically—that is, it is *heterocercal*—which is precisely the case of the ancient ganoids.

Nor is this all. We know that on its emergence from the egg the skeleton of every fish is cartilaginous; so the primeval fishes were mostly cartilaginous.

In the young fish, the mouth is placed transversally below an exceedingly flattened head. It was the same with the primeval fishes.

The stages through which the fish nowadays passes in the due course of its development are, therefore, analogous to those through which the entire ichthyological series has passed in the progress of the geological ages. To the ganoids with an osséous carapace have succeeded the ganoids covered with scales: the skeleton is ossified, the body elongated, the head extended; the mouth has assumed the position which it nowadays occupies; the osseous prolongation which unequally divided the caudal fin has disappeared; and this fin has become symmetrical.

Heckel arrives at the same results as Agassiz. He considers the vertebral column of fishes to have been gradually transformed up to the present period; and he remarks: "The fishes of the geological ages have traversed in myriads of years phases similar to those of the embryonic development of the fishes belonging to the present order of creation."*

---

* The *Pleuronectes*, or flat-fish, make their appearance in the Eocene period. Of this class, the *Platux altissimus* and the *Rhombus minimus* are striking examples. The earliest crabs are also found in the same formation, besides new species of molluscs in almost indescribable abundance. In the Miocene period came perches and shads, showing a gradual approximation to the types of piscine life that now prevail.

BOOK V.—ARTICULATED ANIMALS.

> "Each moss,
> Each shell, each crawling insect, holds a rank
> Important in the plan of Him who framed
> This scale of beings; holds a rank which, lost,
> Would break the chain, and leave behind a gap
> Which nature's self would rue."
>
> JAMES THOMSON, *The Seasons.*

> "Stand still, and consider the works of God."
>
> *The Book of Job.*

ALL the classes of Articulated Animals—Insects, Myriapoda, Arachnida, Crustacea, Worms—are represented in the fossil state. Their number, however, is small, and this branch of paleontology has made comparatively but little progress.

A few *insects* are admirably preserved in the midst of blocks of fossilized resin—amber—which, being in a liquid state when it seized them, has delicately moulded itself upon them; and as the amber is transparent, we may study the insects it envelopes almost as conveniently as living insects.

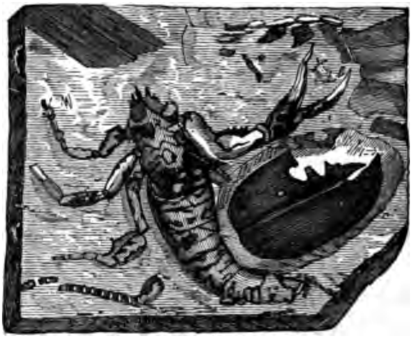
In a stratum of loamy limestone at Puy-de-Covent, in

Auvergne, the outer casing or coat of the larvae or pupae of Phryganidae* have even been discovered.

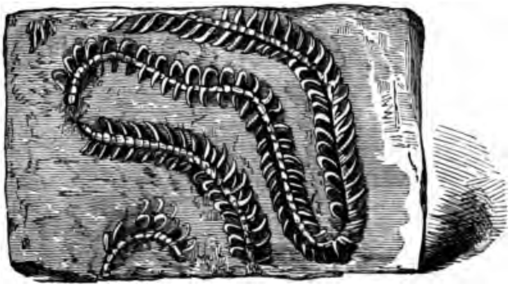
It is believed that fossilized wax has also been found.

Myriapoda are not numerous in a fossil condition, but no more are they in living nature.

It is the same with the *Arachnida*, and we shall confine ourselves here to citing as an example the famous fossil scorpion, *Cyclophthalmus Bucklandii*, discovered in Bohemia in the Carboniferous stage of the Transitional strata.



CYCLOPHTHALMUS BUCKLANDII.



NEREITES CUMBRIENSIS.

Among *Worms*, we meet especially with the tubes enveloping the tubular Annelida; sometimes the impressions of the naked species; and we have one example in the *Nereites Cumbriensis*, which belong to the Silurian stage of the Palaeozoic era.

---

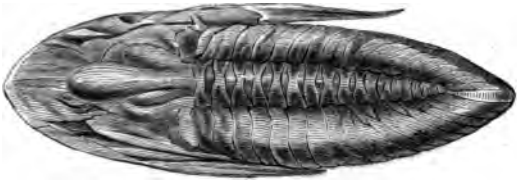
* Caddis-worms.

The class of articulated animals best represented is, however, that of the Crustacea, and the most remarkable animals which it presents are the trilobites.

THE TRILOBITES.

They were excessively abundant in the seas of the Silurian epoch; so abundant, that in certain localities the rock where they are found is almost entirely composed of their remains. They seem, at the epoch we speak of, to have been scattered over the whole globe, for there are few countries in which we do not meet with them.

As the reader will see by the accompanying illustration of one of the species—the *ogýgia*—these crustaceans possessed an ovular body, divided into three lobes by two longitudinal furrows; a circumstance which explains their name. The fore part was armed with a kind of buckler. Their legs were probably numerous, and undoubtedly fleshy; for which reason they have not been preserved. Some species were gifted with the faculty of rolling themselves up into a ball, like the armadillo.



OGÝGIA.

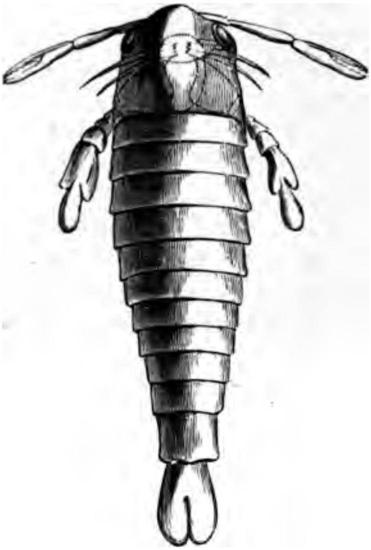
They were marine animals, living in numerous families far from the shore, or else in the shallows, where they swam on their back continuously; their feet being of no use in fixing them, and movement being necessary to their respiration.

Some specimens have been so wonderfully well preserved, that you can study the delicate structure of the eye; and anatomists have discovered that it was formed on the same model as those of crustaceans living in our modern seas; in other words, the eyes were made up of numerous facets. Dr. Buckland has inferred from this fact certain consequences which deserve to be reproduced.

The consequences to which these data lead us, he says, are not of interest only to animal physiology; they instruct us also as to the condition of the seas, and the relations of light with one or other of these two media, at that distant epoch when even the most ancient animals were provided with visual organs, whose most minute optical arrangements were the same which serve even now for the transmission of the sensation of light to the crustacea at the bottom of our present seas.

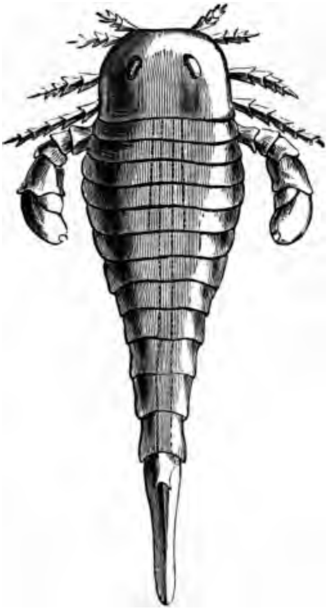
With reference to the nature of the waters in which the trilobites lived throughout the transitional period, we arrive at this conclusion: that it was not the imaginary turbid liquid, formed by a chaos of elements in disorder, whose precipitation, according to certain geologists, will have produced the constituent materials of the earth's crust. For the liquid at whose bottom the eyes of these animals discharged their functions, whatever it was, must, at all events, have been sufficiently pure and sufficiently transparent to permit the passage of light to those visual organs which we find to-day in so perfect a condition, and with whose nature we are so thoroughly well acquainted.

We may arrive at analogous conclusions with reference to light itself; for this resemblance between the organization of the eyes in the primitive ages and at the present epoch, is to us a convincing proof that the mutual relation of these organs and of the rays which transmitted to them the impression of external objects, were just the same at the bottom of the primeval that they are at the bottom of existing seas.



PTERYGOTUS BILOBATUS.

We shall conclude this chapter by placing before the reader the figures of a couple of animals remarkable for their apparently fantastic form. These are crustaceans, but not trilobites, and have been discovered in the Silurian rocks. The one is the *Pterygotus bilobatus*, and the other the *Eurypterus remipes*. They are supposed to have been inhabitants of fresh water. The Scotch quarrymen formerly called them *seraphim*, in allusion to the winged form and feather-like ornament of their thoracic appendage.



EURYPTERUS REMIPES.

BOOK VI.—THE MOLLUSCOIDA.

> **"Light as a flake of foam upon the wind,**
> **Keel upward, from the deep emerged a shell,**
> **Shaped like the moon ere half her horn is filled;**
> **Fraught with young life, it righted as it rose,**
> **And moved at will along the yielding water.**
> **The native pilot of this little bark**
> **Put out a tier of oars on either side,**
> **Spread to the wafting breeze a twofold sail,**
> **And mounted up and glided down the billow**
> **In happy freedom, pleased to feel the air**
> **And wander in the luxury of light."**
>
> JAMES MONTGOMERY, *The Pelican Island.*

IN direct opposition to the articulated animals, the Molluscs possess a considerable importance in paleontology. Of these alone, three times as many fossils are counted as of all the rest of the animal kingdom. Their shells form entire strata. Sometimes these shells have been deposited slowly at the bottom of tranquil seas; and we find them admirably preserved, with all their striations, their ridges, and even their colours; at other times they have been crushed into dust by the violent action of the restless waters. In certain localities the paleontologist meets with every possible transition between these two extremes.

The most remarkable fossil molluscs belong to the class of *Cephalopoda;* they are the belemnites and the ammonites.

The reader is probably aware that this class is divided into two orders.

The one comprehends animals with eight or ten arms furnished with suckers or mandibles: these are the *Cephalopoda acetabulifera*, such as the poulpes, the argonauts, the cuttle-fishes, and the calamaries. To this group belong the belemnites.

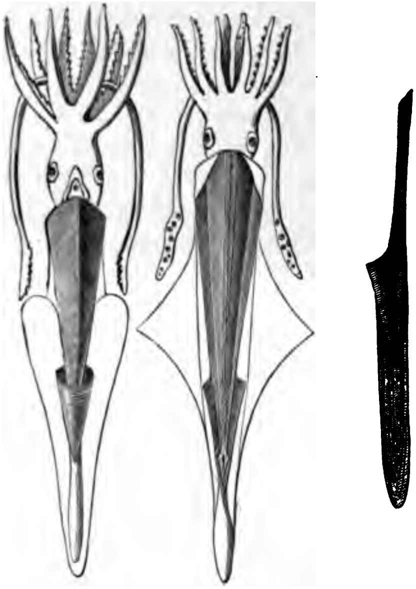
The other order includes all animals with numerous short tentacular arms, without suckers or mandibles. These are the *Cephalopoda tentaculifera*, such as the nautilus; and to this group belong the ammonites.

I. THE BELEMNITES.

The *Belemnites*, then, are acetabuliferous cephalopods. Their shell—and nothing else of their organization has been handed down to us—was, like the *bone* of the cuttle-fish, an *interior* shell.

These bones, which, at the first glance, you might take for petrified wands or rods, have engaged from all time the attention of naturalists: they do not belong to the production on whose origin further discussion is necessary. *Spectorum candela, digiti diaboli*, are some of the names which have been given them; and from these names it is easy to conjecture with what fables they have been associated. The ancients asserted they were petrified lynx's urine, whence the name of *lyncurium;* others looked upon them as stones which had accidentally received the form of javelin points.

Matthioli was fain to see in them bits of petrified amber; Caesalpinus, fragments of shell; Mercati, fossilized dates; Rumphius, thunderbolts; Klein, the prickles of sea-hedgehogs—an opinion adopted in our own days by Beudant. It was Deluc who discovered that they were simply the internal bones of fishes resembling our modern cuttle-fish.



BELEMNITES, RESTORED.

The accompanying illustration, after D'Orbigny, will show the reader the composition of this object, and its place in a restored belemnite. It was composed of three parts.

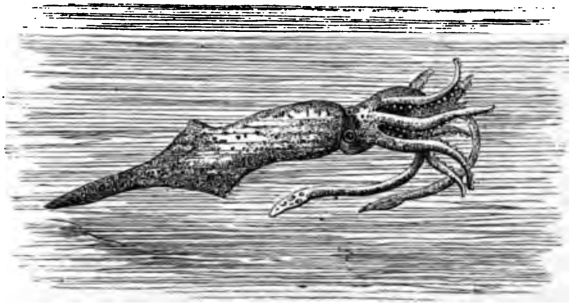
The anterior is a horny blade, shaped like a spatula enlarged in front, and contracted in the rear.

The middle part, or *alveolus*, is a deep cup or calyx, of conical form, containing a series of aërial compartments traversed by a central siphuncle (or tube).

The hinder, or after part, covering and protecting the alveolus, is a calcareous incrustation, more or less elongated, and constituting an unmistakable terminal *rostrum* or beak. This last part it is which we find most frequently in the strata of the earth, and numerous specimens may be seen in every geological collection.

The anterior portion served as a support for the flesh.

The middle portion (*alveolus*), when filled with air, compensated the enormous weight of the calcareous rostrum, which, unless it had been thus lightened, would have compelled the animal to preserve a vertical position, while its normal one was horizontal, as may be seen in the subjoined illustration.



BELEMNITE SWIMMING.

The function of the hard and calcareous rostrum was to protect the soft parts of the body against the shocks to which the animal was exposed during its swimming backward.

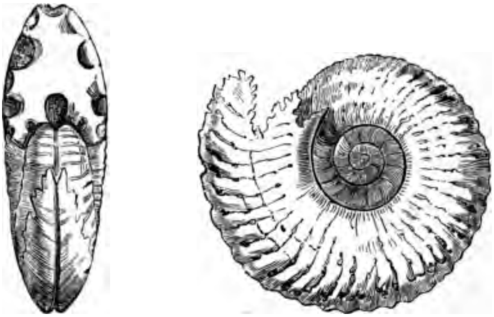
Its existence shows that the belemnites must have been—what shall we call them?—molluscous coasters, or coasting molluscs, as their much elongated form indicates that they were slender of form, and good swimmers. From the dimensions of some of these rostra, it may be conjectured that certain species were upwards of a yard and a quarter in length. A few well-preserved examples have enabled our anatomists to detect that, like the cuttle-fishes of our present seas, they were provided with an ink-pouch. Probably they were carnivorous animals. More than sixty species have been determined.

II. THE AMMONITES.

The *Ammonites*, as we have said, are tentaculiferous cephalopods; a group which has but one representative among living beings, the dainty nautilus. The ammonites exist only in a fossil state; and in a fossil state they are found in all regions of the globe. They swarmed in the seas of the Secondary epoch, for they were marine animals.

Like the nautilus, and like all molluscs of the same order, they were provided with an external shell of a regular spiral form, which was so excessively thin that only its moulds are ever found; moulds composed of ferruginous, calcareous, or quartzose materials. Their dimensions vary from one line to eight feet in diameter. The number of species is considerable. Alcide d'Orbigny counted five hundred and thirty.

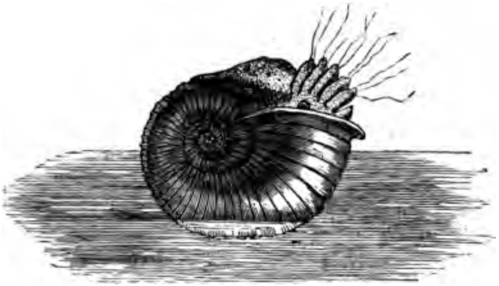
The shell was divided into a series of more or less numerous compartments; an arrangement which we meet with among all the tentaculiferous cephalopods, and consequently in the nautilus. These chambers, whose number increased with the animal's age, had the effect of compensating the corresponding increase of weight. Some ammonites have three or four partitions in their spiral fold; others comprise upwards of one hundred. The animal occupied the cavity in front of the last partition; a cavity which, in various individuals, consisted of from half a turn to an entire turn of the spiral.



AMMONITES.

The partitions were secreted by the hinder part of the mollusc, and each of them marks the place which this hinder part has filled in proportion to its growth. All are traversed by a tube named a *siphuncle*, placed on the dorsal side of the shell. A similar siphuncle exists in the nautilus, but it is more central. From the structure of the latter animal it is evident that this siphuncle accommodated in the ammonite a cylindrical fleshy organ placed at the extremity of the body, and by the aid of which the animal adhered to the bottom of its shell. But the siphon being dorsal, this mode of attachment secured it but a very imperfect equilibrium. Its rolling was prevented, however, by the deep ridges or hollows into which the partition that served as the ammonite's asylum was hollowed in its circumference. Into these fine and elegant indentations, which have been compared to those of parsley leaves, the lobes of the mantle really penetrated. But the siphuncle had not only the function of which we have spoken; according to all appearance, in one way or another it supplied the ammonite with the means of rendering itself heavier or lighter at will; I say, in one way or another, because the exact mode has not been ascertained. According to M. de France, the siphuncle served to dilate and compress the air enclosed in the chambers, and Buckland has adopted this opinion; but Alcide d'Orbigny offers a very different explanation. He asserts that the siphuncle did not communicate at all with the interior of the chambers; it was an independent tube, and completely closed up, except at the anterior part; but he supposes that the organ which it enclosed was hollow, and that this hollow organ, this tube, might alternately fill itself with water, and empty itself, and that, by this device, the animal rose or sank at its pleasure. It is probable, moreover, that, like the nautilus, it floated on the surface of the waters, as shown in our accompanying illustration.

The extreme abundance and remarkable form of these shells have rendered them an object of curiosity from remotest times. They were supposed to be petrified serpents, and in the writings of antiquity we find them designated *serpens lapideus*.



AMMONITE, RESTORED.

They are called ammonites from their resemblance to the ram's horns sculptured among the ornaments of the temples of Jupiter Ammon; and for this cause they were regarded with peculiar reverence in Egypt and Ethiopia. They have been also the object of a species of *cultûs* among the Hindus. The Brahmins preserved them in costly caskets, and offered up a sacrifice to them daily.

The ammonites made their first appearance, but in limited numbers, towards the end of the Triassic period. In the Secondary epoch they became remarkably numerous, and in the Jurassic period the species were abundant and beautiful. At the close of the Secondary epoch they disappeared.

Quantities of specimens are found on the coast of Yorkshire, in the neighbourhood of Whitby. They were formerly known as St. Hilda's Beads, as Scott reminds us in his poem of " Marmion."

BOOK VII.—THE RADIATA.

> "Let us then consider the works of God, and observe the operations of his hands: let us take notice of and admire his infinite wisdom and goodness in the formation of them. No creature in this sublunary world is capable of so doing beside man; yet we are deficient herein: we content ourselves with a knowledge of the tongues, and a little skill in philology, or history perhaps, and antiquity, and neglect that which to me seems more material, I mean natural history and the works of creation. No knowledge can be more pleasant than this, none that doth so satisfy and feed the soul; in comparison whereto that of words and phrases seems to me insipid and jejune."—JOHN RAY, *The Wisdom of God manifested in the Works of Creation* (ed. 1691).

WE have now to treat of animals of the lowest rank in the economy of Nature, so far as relates to simplicity of organization. But if we regard them from a geological point of view, we shall find that, in comparison with the part played by these apparently insignificant creatures, that of the giants of the Animal World, of the mastodon and the megatherium, the plesiosaurus and the ichthyosaurus, is utterly trivial and valueless.

Such is the geological importance of these tiny creatures, that it is equalled only by that of the great physical agents, the central fire and the waters of ocean. Immense terrestrial strata and whole mountains have been entirely built up by their unaided labours, not simply formed of their *débris*, as is the case with shell-fish ; living zoophytes have erected these gigantic piles. These are the architects of our islands and continents, the builders of worlds.

In this mode of formation nothing mysterious exists, for we see it in operation in our own days. Everybody knows that the *coral banks*—such is the collective name commonly given to the polypids—are everywhere rising with a remarkable rapidity, so that in a few years many parts of the ocean will be rendered impassable to which our mariners have hitherto had free access. On the coast of Australia, a channel which but some short time since included only twenty-six islands, is filled to-day with one hundred and fifty.

It is principally in the South Seas that the polypes are now at work. In the neighbourhood of the Maldive Islands they form a mass whose volume is equal to that of the Alps.

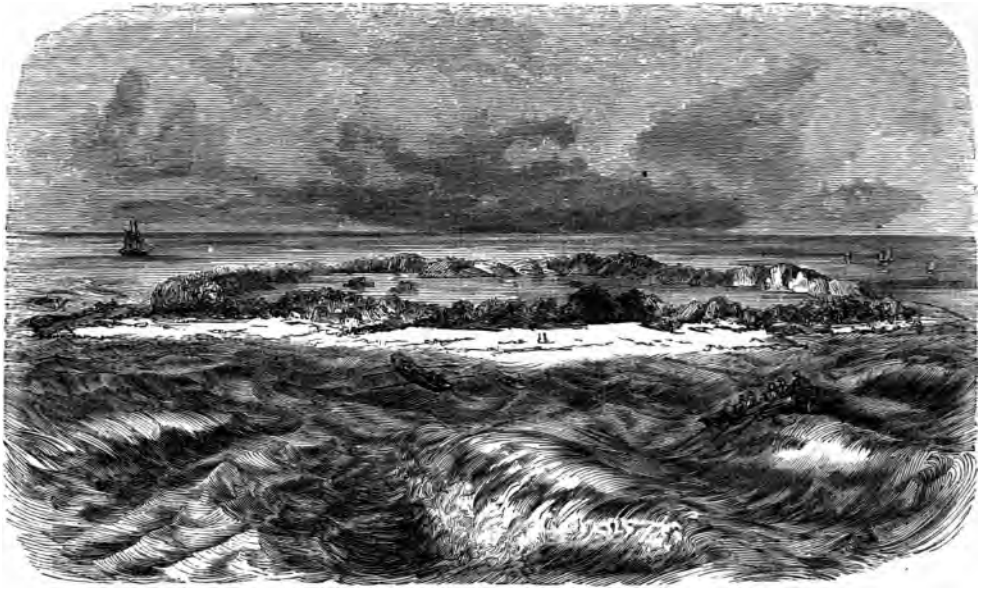
They have built, says Professor Owen, a barrier of reefs, four hundred miles in length, around New Caledonia, and another, which stretches along the north-west coast of Australia, one thousand miles in length. And these mighty works have been executed in the midst of the ocean-waters, in spite of the tempests, which so swiftly annihilate the solidest works of man.

The Low Archipelago, the Society Islands, the Gilbert Islands, the Marshall Islands, the Caroline Islands, and innumerable reefs and islets, extending diagonally in the Pacific Ocean over a length of more than thirteen thousand kilomètres, and an average breadth of two thousand, have been, and are constructed by them.

These islands, named *atolls* or coral islands, are nearly always of a circular form, with a depression in the centre: whence it would appear that the polypes prosper best where the Ocean is most agitated, this agitation bringing within their reach a more abundant nourishment. Their nourishment consists of infinitesimal *débris* of animal matter; for, as Dr. Buckland has remarked, their function, in addition to that of concreting the calcareous salts suspended in the sea, is to clear the latter of the most tenuous portion of the putrescible substances it also holds in suspension.

Gradually the great waves bury in the centre of the islet the refuse torn away from its circumference; the interior cavity fills up; firm land appears; soon winds, and birds, and currents bring thither the seeds of many a plant, and a new garden blooms in the bosom of the deep waters.

Mr. Darwin has eloquently painted the struggle thus successfully waged by the animalcule against the ocean. He visited the circle of reefs which forms the *lagoon*, or inner lake, of the island of Cocos. Into this lagoon he passed through a narrow channel which wound its way among delicately ramified corals. Having reached the further end of the lagoon, he landed, and crossed to the windward side of the island, to watch the open sea dashing in foamy breakers on its shore. The spectacle was one of imposing magnificence—graceful cocoa-palms, lines of verdurous shrubs, a broad margin of "yellow



ATOLL, OR CORAL ISLAND.

sands," an impassable barrier of enormous rocks, and the fringe of weltering waves which was carried all around the reef. These were the principal details in a very novel and impressive picture. The ocean, like an invincible and all-powerful enemy, hurls its waves against the rampart, only to fall back repulsed and conquered by the simplest means. Not, indeed, that it spares the rocks of coral, whose gigantic fragments cast upon the shore proclaim its power; it will make no peace, it will grant no truce; it is never weary, never in need of rest; the prolonged swell, raised by the gentle but continuous action of the Trade winds, blowing always in the same direction over this immense area of waters, gathers up in billows almost as high as those which are accumulated by the storms of our temperate zones. Looking upon their incessant fury, you will feel convinced that the most impenetrable rock, be it porphyry, or granite, or quartz, would be demolished by a force so irresistible, while the humblest shores would remain victorious. Another power has taken part in the strife. The organic force seizes one by one the atoms of carbonate of lime, and separates them from the boiling foam to re-unite them in a symmetrical structure. What matters it that the tempest sweeps away in millions enormous blocks of rock! What avails it against the unresting toil of myriads of architects, working night and day! Here we see the soft and gelatinous body of a polype conquer, through the action of vital laws, the immense mechanical power of the ocean-waves, which neither the art of man can resist, nor the inanimate works of nature.

Pyrard de Laval, describing in 1601 the Malouine Islands, speaks of similar scenes, though in less philosophical language.

They are divided, he says, into thirteen provinces, named *atollons;* a division suggested by the character of the localities, for each atollon is separated from the others, and includes in itself a great multitude of miniature islands. Wonderful it is to see each of these atollons surrounded by a great encircling bank of stone. No human skill could so impregnably enclose with walls an area of ground.

These atollons are almost circular in shape, or oval; each is about thirty leagues in circumference, some a little more, and some a little less; and all lie in a row; extending from north to south, though without touching at any point. A channel, broad or narrow, as the case may be, separates the one from the other. Situated in the centre of an atollon, you see all around you this great wall of rock, which encircles and defends the island against the impetuosity of the sea. But it is a frightful thing, even for the boldest, to approach this reef, and to see the waves coming from afar to dash with fury all about and around it.

Not only the archipelagoes of Polynesia owe their existence to the coralline polypes, but without the incessant labour of the latter all these islands would long ago have disappeared, for this vast extent of sea is gradually sinking. The increasing height of the polypids compensates, however, for the lowering in level of the sea-bed, and the islands thus maintain their position above the surface of the waters.

From these few data the reader will understand the importance of the part played by the polypes in the ancient history of the globe. All Germany rests upon a bank of coral.

Their mode of production is still, to some extent, an unfathomed mystery ; but we owe much to the persevering investigations of Charles Darwin, M. Lamaroux, and M. Alcide d'Orbigny. In the primeval world the polypes seem to have been most active during the Oolitic period ; but there is no reason to believe that they ever altogether rested from their wonderful and valuable labours.

BOOK VIII.—THE PROTOZOA.

> " 'Tis hard to tell of Work begun,
> Of Work completed, Work undone,
> And all the wonders that are wrought
> By tiny agents of God's Thought."
>
> ANON.

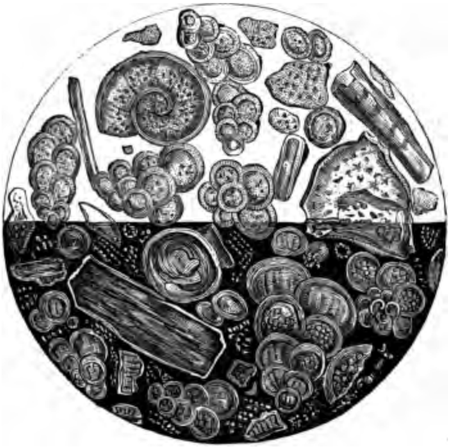
IN geological importance, it cannot be said that the work of the Protozoa is inferior to that of the Radiata.

We know that the Protozoa are divided into *Foraminifera*, *Infusoria*, and *Spongiaria.* Let us briefly survey each of these great and interesting groups.

The *Foraminifera*, or, at least, the majority of them, are microscopic animals, and, on account of the resemblance of their shells to that of the nautilus, they were long confounded with the cephalopods. The chalk which throughout our world accumulated in such immense beds is almost entirely formed of these miniature shell-fish.

The *Miliolites*, so called because their volume does not exceed that of a grain of millet, and is frequently less, form entirely the stone known to geologists by that of miliolite limestone, or *calcaire grossier*. M. de France has ascertained that a cubic line of *calcaire grossier* includes ninety-six miliola! Paris is wholly built of these microscopic shells.

The *Nummulites*, another tribe of foraminifera, are still more astonishing.



SECTION OF A PIECE OF MEUDON CHALK.

They derive their name from their discoid form, which is that of a piece of money (*nummulus*); and therefore they are sometimes termed "nummulite-stones." They are also called "lenticular-stones," because they have the form of lentil-seeds; and the largest are much larger than those seeds.

The nummulites are met with in prodigious quantities in the Secondary and Tertiary strata, and constitute the sole material of enormous beds. Laon stone, frequently employed by the French architects, is completely formed of nummulites; and so is the Arabian chain of hills which skirts the Valley of the Nile. In different regions of Upper Egypt, the soil of the desert simply consists of a thick bed of nummulites, in which the feet of the traveller and the hoofs of his camel slip and sink.

A NUMMULITE.

The mighty and imposing Sphinx, that mysterious monument of Egyptian worship, was sculptured out of a block of nummulites. Some of the Egyptian Pyramids, whose materials were brought from the Arabian heights, are also made of nummulites. Time, says Pouchet, by gnawing at the surface of these gigantic memorials, has accumulated enormous masses at their base, where they impede the visitor's progress. In Strabo's days it was pretended that these were the lentils abandoned by the workmen of old, and fossilized by the action of time; but the Greek geographer refuted this absurd tradition, and, in his description of Egypt, he classes the nummulites in the number of petrifactions.

To the class of Foraminifera belongs the most ancient fossil animal discovered up to the present day.

A geological survey of that portion of Canada which lies to the north of the St. Lawrence, accomplished under the direction of Sir William Logan, has recently led to the discovery of a series of stratified and crystallized rocks of gneiss, mica-schist, quartzite, and limestone—a series thirteen to fourteen thousand mètres in thickness, to which, on account of its geographical position, has been given the name of *Laurentian.*

These rocks are as old as, if not older than, any of the so-called *azoic** formations of Europe; formations so named because they exhibit no single vestige of ancient forms of life, and have, therefore, been considered as anterior to the creation of the latter.

And yet, in the lowest, the most ancient system of this vast Laurentian series, in a limestone about three hundred and thirty mètres thick, Professor Dawson of Montreal, who has studied it with the microscope, has detected organic remains—those of a great species of foraminifera—and beautiful examples of this fossil, the *eozoon canadense,* have been sent to Europe. Life, therefore, is much more ancient upon the globe than up to the present time our geologists, in their strict adherence to old traditions and so-called facts, had suspected.

Let us pass on to the *Infusoria.*

The city of Berlin is built on a bed of living infusoria, about sixty-six mètres in thickness. We are speaking of microscopical animals, ten thousand of which ranged side by side will not cover a greater extent than twenty-seven millimètres, while it takes a million to make a milligramme.

In the heathery moorlands of Lunebourg a bed of the same kind is known to exist; but this does not exceed seventeen to eighteen mètres in thickness.

---

* That is, "without life."

Some others are known, of less importance, in North America: they are only six to seven mètres thick.

This explains to us how it is that certain ancient rocks, stratified beds of great solidity, and actual mountains, are entirely formed of the shells of infusoria.

According to Ehrenberg, a cube of chalk of twenty-seven millimètres is made up of a million of these microscopic animals.

Schleiden estimates that the layer of chalk which covers the surface of a carte-de-visite represents nearly one hundred thousand shells of animalcules.

The *tripoli* of Billin, in Bohemia, as well as that of the Mauritius, is entirely composed of siliceous shells so perfectly preserved, that Ehrenberg, to whom we owe the discovery, has been able to compare them with the shells of those living animalcules to which they present the greatest analogy.

Twenty-seven cubic millimètres of the Billin *tripoli* do not contain less than forty-one millions of infusoria!

Now the schists of Billin extend over a surface of thirty-two to forty square kilomètres, with a depth varying from sixty-six centimètres to five mètres. Let the reader pause, and reflect upon the full meaning of these figures.

Certain tripolis of a reddish colour are used in some European provinces for colouring the fronts of houses, and everywhere for scouring and polishing the implements of the kitchen; these houses owe their bright hue, and these utensils their brilliancy, to fossil animalcules.

We meet with them even in the most compact rocks. Mr. White particularizes twelve species which are found in the flints of the chalk.

Certain tribes, in Asia and America, include various nutritive clays in their alimentary regime; these clays are partly composed of fossil animalcules.

A word upon the *Sponges*.

We are aware, of course, that the majority of them possess a soft and corneous domicile; that others are composed simply of siliceous fibrils, which, at the slightest pressure, snap like threads of glass. Some writers have advanced the hypothesis that these sponges have co-operated with the infusoria in the formation of the flints of the chalk. Such is the opinion of Sir Charles Lyell. "The vast mass of chalk," he says, "which in England consists of soft white earthy limestone, contains, in the upper part, numerous bands of interstratified flints, which were mostly sponges originally, that have since become silicified and converted into flint." And it is certain that in some kinds of flint we can detect unmistakable remains of sponges. We meet with them likewise in the jaspers and agates. The remains of these minute forms of life have been handed down to us as securely as those of the mightiest monsters of the Primeval World.

BOOK IX.—PRE-HISTORIC MAN.

"And God said, Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.

"So God created man in his own image: in the image of God created he him; male and female created he them."—*Genesis.*

I.

WE come now to the consideration of a question of peculiar interest. Was Man a contemporary of any of the animals we have described?

To this question Cuvier gives a decided negative answer.

In an earlier chapter we have seen that he was astonished at the non-discovery of a single ape or a single quadrumane among the fossils.

Having established the fact of their absence, he added: "Nor did man exist. All the human bones which have been collected in association with those of animals were found there accidentally; and their number, moreover, is *so* infinitely small. This, assuredly, would not have been the case, had man dwelt in the countries which these animals inhabited."

One of the chapters of this illustrious naturalist's "Discours sur les Révolutions du Globe," is entitled: *Il n'y a point d'os humains fossiles*—There are no human fossils.

"I assert," he writes, "that no human bones have been found among the fossils, that is, among fossils properly so called, or, in other words, in the regular strata of the surface of the globe: for in the peat-beds and in the alluvia, as in cemeteries or graveyards, we can as easily distinguish human bones as the bones of horses and other vulgar species. We may find them likewise in the fissures of the rock, in the caverns where the stalactite has accumulated upon them; but in the strata which conceal the ancient races, among the palaeotheres, and even among the elephants and rhinoceroses, the smallest human bone has never been discovered."

And passing in review the facts then brought forward in proof of the statement that man had been a contemporary of some extinct species, he shows, without difficulty, that most of these facts had been imperfectly considered, and in no wise prove what they have been supposed to prove.

"There are few workmen around Paris," he says, "who do not believe that the bones with which our plaster-quarries swarm are, in great part, the bones of men; but as I have seen several thousands of these bones, I may be allowed to affirm that not a single one belongs to our species. The *Homo diluvii testis* of Scheuchzer has been referred to its true genus, that of the salamanders; and in an examination which I have since made at Haarlem, through the goodness of M. Van Marum, who has permitted me to open up the portions concealed in the rock, I have obtained a complete confirmation of my former statement. Quite recently it has been pretended that bones have been found at Marseilles, in a stratum (*une pierre*) long neglected; they were impressions of marine tubes. The veritable human bones were those of corpses which had fallen into the fissures of rocks, or lain in the ancient galleries of mines, or become covered with incrustations; and I extend this assertion to the human skeletons discovered at Guadaloupe in a rock composed of fragments of madrepores cast up by the sea, and united by a calcareous cement. The iron tools discovered at Montmartre are the pikes employed by the quarrymen in digging holes to receive the charges of gunpowder, and which sometimes break in the stone."

Science herself speaks here by the mouth of Cuvier. But while the great anatomist exposes the errors of others, he is, in his turn, totally mistaken as to the value of some of the facts submitted to his examination. As, for instance, when he writes :—

"A great noise was made some months ago in reference to certain human fragments found in the bone-caverns of our southern provinces; but it is enough that they were found in the caverns to bring them under our law."

But not only do our geologists and paleontologists no longer refuse the evidence of the caves, but, in addition, the particular facts which Cuvier had in view are now placed among these which demonstrate the existence of Fossil Man.

For that man belonged to pre-historic times is very generally admitted, and the sole problem to be solved is, the particular geological period to which he belonged.

II.

An eminent French physicist, who has taken a brilliant part in the exploration of the caverns of the south, Dr. Garrigou, has recently put forward the opinion that man may be as ancient as the Miocene, or mid-period of the Tertiary epoch.

"From the moment," he writes, "when mammals of so perfect an organization as the mastodons, lions, hyenas, and stags could live in the Miocene air, and adapt themselves to a climate which their presence indicates to have been healthy, from the moment in which M. Lartet has shown us an ape co-existing and developing along with these mammals, why should not man have lived as their contemporary?"

This is just the reasoning employed by M. Boucher de Perthes, some twenty or thirty years ago, to prove that man must have lived in the Post-Tertiary epoch. Events have justified this reasoning. And be it remembered that there exists no physiological reason why man should not have lived where an anthropomorphic ape, the *Dryopithecus Fontanii*, lived. But if this remark should secure our attention to the facts by whose aid we may wish to demonstrate hereafter that the human race dates back to so remote a period, it cannot usurp the place of these facts themselves. Hitherto we have no proof that man existed in the Miocene period. Let us, then, survey, in succession, the geological ages, and observe in which of them the evidences of human existence are to be found.

III.

Above the Middle Tertiary strata (or Miocene) we meet with the Upper Tertiary, or Pleiocene.

To the Pleiocene belong the sand-beds of Saint-Priest, in the department of Eure-et-Loire, celebrated among paleontologists on account of the great abundance of their remains of *elephas meridionalis*, *rhinoceros leptorhinus*, *hippopotamus major*, great oxen, immense stags, and horses; and the presence of these remains is a proof that the strata where they are found belong to the Upper Tertiary.

Now, M. Desnoyers asserted, some seven or eight years ago, that the major part of the bones proceeding from the sand-beds of Saint-Priest bear the impress of the hand of man.

On an elephant's skull he showed the mark of arrows which, after penetrating the skin and flesh, had grazed the bone. He showed that all the crania of the great stag, named *Megaceros Carnutorum*, appeared to have been broken by a violent blow on the frontal bone, near the point of insertion of the two antlers; that at the base of these antlers were traced incisions directed laterally, and from top to bottom, as if done by a sharp-edged weapon which had been employed in removing the flesh and detaching the tendons; that the bones of the ruminantia are broken lengthwise and athwart, apparently with the view of extracting their marrow.

Some geologists have adopted the opinion of M. J. Desnoyers; others reserve theirs. A stag's head discovered at Saint-Priest was pierced with a hole evidently made during the animal's lifetime; it is supposed that it was the result of one of these furious combats in which, at certain epochs, the deer engage among themselves. Most of the bones of Saint-Priest are marked with striations and fissures of every kind; but, as has been ascertained from experiments made in the Zoological Garden of London, the porcupines handle in nearly the same manner the bones which they get hold of, and at Saint-Priest there has just been the jaw of a great rodent discovered.

Finally, we are led to remark that neither tool, weapon, nor instrument has been discovered in this neighbourhood; and in their absence, the proofs on which so much stress was laid by Desnoyers seemed insufficient even to geologists who, like Sir Charles Lyell, were inclined to admit that man was living at the epoch when the Tertiary strata were deposited.

Now, the evidence asked for by Sir Charles Lyell has been recently produced by the Abbé Bourgeois in a note laid before the French Academy. He writes as follows:—

"I have not met, it is true, with the classical form of Saint-Acheul and Abbeville; but I have succeeded in collecting at all levels the commonest types, such as the heads of arrows or spears, bodkins, scrapers, hammers, and the like. One of these instruments looks as if it had been subjected to the action of fire.

"The flint implements found in the sand and gravel of Saint-Priest are very rough, and exhibit a striking resemblance to those which I exhumed in the *diluvial* of Vendôme."

If these facts may be accepted, man belonged to the Upper Tertiary formations.

And if this be true, he ought to have left some traces in the succeeding strata, that is, in the Post-Tertiary.

Let us examine these.

IV.

Lartet, the renowned French geologist, divides the Post-Tertiary period into four paleontological ages, which we numerate in their order of antiquity:—

1. The age of the cave-bear;
2. The age of the *elephas primigenius*, or mammoth;
3. The age of the reindeer; and
4. The age of the *aurochs.*

The cave-bear disappeared before the mammoth, the mammoth before the reindeer, and the reindeer before the aurochs.

Before going any further, let us suppose that no person has now any doubt that in the south of France man lived contemporaneously with the aurochs, which is no longer found except in forest-recesses of Lithuania, Russia, and the Caucasus—and that he lived there at a still remoter period, contemporaneously with the reindeer, which is now met with in the Polar regions only.

Now, one of the most decisive proofs of the co-existence of man and the reindeer in the Mediterranean regions of France, is furnished by the state of the bones of this ruminant, found in the caves pell-mell with objects of human industry, or even with human bones. All these bones, in fact—at least, the long ones—have been broken in the same manner, for the purpose evidently of extracting the marrow. Which proves that at this remote epoch man acted, as, at the present day, the peoples of the Arctic regions act—the Lapps, Eskimos, Samoyedes, and Kamtschatdales.

This settled, it is evident that it will suffice to find the bones of the cave-bear similarly broken—that is, like those of the reindeer—to prove that man was a contemporary of the *ursus spelaeus.*

For this proof we are indebted to the labours of Messrs. Garrigou and Filhol :—

"We had occasion," they write, "some two years ago, to present some bones of the *ursus spelaeus*, *felis spelaea*, and *rhinoceros tichorhinus*, which we thought shaped and wrought by the hand of man.

"These were some under jaws of the great bear and great cave-cat, whose hinder part, very regularly rounded—for the purpose, undoubtedly, of being held more easily in the hand—formed with their menacing tusk (*canine*) a formidable weapon, or an instrument useful in polishing stone. There were the long bones of great bears shaped like knives; a left side of the lower jaw of the same animal completely traversed by a blow from a sharp instrument, and bearing the pathological signs of an injury to the bone from a long-continued wound. There were also the tibias and humeruses of the *rhinoceros tichorhinus* broken in their diaphyses like those we have described of reindeer and aurochs, sheep and goats. The fractures made in these bones had often afforded a holding-place for the teeth of the great carnivores.

"To these pieces, whose number we have considerably augmented, we must add a series of bones of great cave-bears and great cave-cats, broken like those of the age of the reindeer, of the age of the aurochs, and of the age of the polished stone."

We might bring forward other facts in support of the contemporaneous existence of man and the cave-bear. The following is specially curious:—

The Cave of Aurignac, situated in the arrondissement of Saint-Gaudens, in the department of the Haute Garonne, about fourteen mètres above the brook of Rodes, in the escarpment of a limestone rock, is seven feet deep, and seven and a quarter feet high; the entrance, which is arched, measures about two feet wide. An accident revealed its existence about fifteen years ago to the person charged with keeping in repair the neighbouring road (*route de Boulogne*). When the approaches of the grotto, encumbered with fragments of rock and vegetable mould, were swept clean, he found himself in front of a great vertical slab, some centimètres in thickness, which closed the entrance.

This slab removed, he and his companions discovered a great quantity of bones and human skulls. On a careful examination, they discovered seventeen skeletons, including some of women and some of children. The discovery, as the reader will suppose, made a great noise; it gave rise to the most ominous conjectures, not one of which, however, could sustain criticism. It became evident that this cave was neither more nor less than a burial-place, which, like our family vaults, had received successively the corpses of those whose remains it enclosed. But at what epoch? This question the authors and witnesses of the discovery, who were neither archaeologists nor paleontologists, were unable to answer. And so they interred the bones in the parish cemetery.

In 1860 M. Lartet chanced to visit this locality. Hitherto Aurignac had not been honoured with the presence of a man of science. His first care was to make himself well acquainted with the result of observations made prior to his arrival. Next he proceeded to study the ground. Having removed with the greatest care the mound operated upon some years before by the first explorers, both in the interior of and outside the grotto, he discovered that a platform, perfectly levelled, and from three to four mètres square, extended before him.

On this platform he found a layer of ashes and coal, fragments of stone which had undergone the action of fire, and among these numerous pieces of bone, some of carnivorous, but most of herbivorous animals. Many were entirely carbonized; others only scorched and reddened. The bones of the herbivores, and particularly those with the medular cavity, had all been broken in an uniform manner, as if for the sake of extracting their marrow. Many had been scraped or notched by sharp-edged instruments. Other bones, which had not been exposed to the action of fire, bore the deep indents of the teeth of great carnivores; and coprolites, or petrified excrements, scattered here and there, proved that the hyena had been one of these. And, finally, amidst these *débris* lay a great number of different projectiles of an angular shape, and of those flint splinters to which archaeologists have given the name of *knives.*

FLINT SCRAPER.

FLINT KNIFE.

Researches, methodically conducted, both in the interior of the cavern and on its platform, placed M. Lartet in possession of a great quantity of primitive instruments and of the bones of animals of extinct or living species. The instruments are, first, of flint, as will readily be supposed; then polished blades of reindeer-horns; a canine tooth of the *ursus spelaeus*, which had evidently been worked; there were also bone and shell ornaments.

The bones of animals are, *Herbivorous :* elephas primigenius, rhinoceros tichorhinus, megaceros Hibernicus (great Irish elk), bison priscus (perhaps the origin of the aurochs); *Carnivorous;* ursus spelaeus (great cave-bear), ursus arctos, wolf, fox, felis spelaea (cave-cat), wild-cat, and hyena. Observe that no vestige has been found of the existence of the dog.

A dozen human bones were also embedded in the shifting earth of the cavern; but it was found impossible to recover those which had been buried in the cemetery.

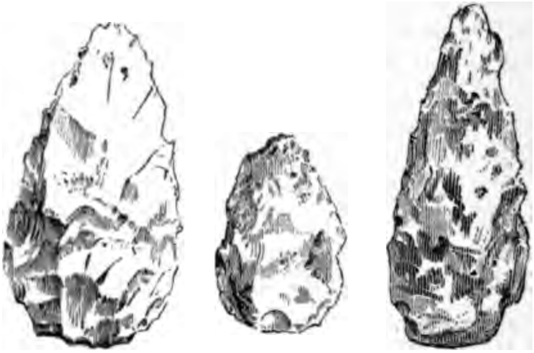
Such was M. Lartet's discovery. It leads to the conclusion that the human bones of Aurignac belonged to a race contemporary with the great extinct mammals, and, in particular, of the great cave-bear. This cavern was one of their burial-places; they had seated themselves around this common hearth.

The use of metals seems to have been unknown to them, for the memorials they have left behind them exhibit no trace of it. They made use of implements and weapons of bone and flint, and lived on the products of the chase. When the tribe encamped at Aurignac lost one of their members, the corpse of the deceased was removed into the cavern, and the remains of certain animals were deposited with it. The survivors afterwards proceeded, in the presence of the dead man, to enjoy a funeral banquet; then, the cavern being reclosed, they abandoned the remains of the feast to wandering beasts of prey.

V.

Let us pass on to the *Diluvium* properly so called. It is posterior to the age of the great cave-bear, for in it we meet with no remains of this carnivore.

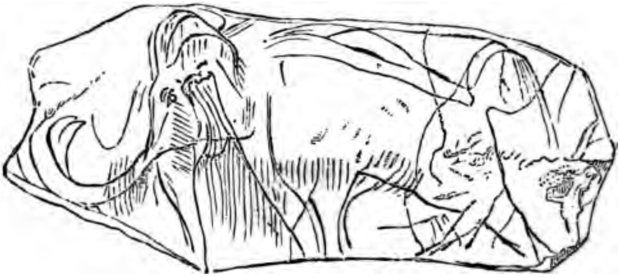
One of the most illustrious of French archaeologists, M. Boucher de Perthes, has maintained, during a great part of his laborious career, the co-existence of man and the mammoth in the diluvial strata. The proofs he has brought forward consist exclusively of innumerable implements of flint (hatchets, knives, wedges, and the like), shaped, but never polished, which he has found in the *diluvium* of Picardy, near Abbeville and Amiens. More recently, he has collected a great quantity of human bones in the same strata, and particularly a lower jaw, which has given rise to a celebrated discussion.



FLINT IMPLEMENTS FROM ABBEVILLE.

We might quote many other facts in support of the contemporaneity of man and the mammoth, but we shall confine ourselves to the following.

In May 1864, accompanied by Dr. Falconer, M. Lartet visited the bone-caverns of the Dordogne. When they arrived at the deposit of *la Madelaine*, the labourers had brought to light five fragments of a plate of ivory anciently detached from an elephant's tusk of considerable size. After putting together these fragments as carefully as possible, M. Lartet pointed out to his companion numerous lines which had been scratched upon them lightly, and which, as a whole, appeared to indicate the figure of an animal. The skilful eye of the English paleontologist, who had been accustomed to study the proboscidians, immediately made out an elephant's head; and, afterwards, he detected other parts of the body, and, principally in the region of the neck, a mass of descending lines which reminded him of the mane and the long hairs characteristic of the mammoth, or elephant of the Glacial Age.



ENGRAVED PLATE OF IVORY,
From the Bone-caverns of the Dordogne.

We are informed by M. Lartet that not only Dr. Falconer and himself, but Milne-Edwards, Quatrefages, Desnoyers, and other eminent scientific men, have recognized in this rude primeval drawing the representation of the *elephas primigenius.*

This new fact, he adds, will, nevertheless, in no wise strengthen the conviction men of science had already formed of the co-existence of man with the fossil elephant, and the other great carnivores or herbivores which geologists believe to have flourished in the early stages of the Post-Tertiary period. This "verity of retrospective evidence" is now inferred from so great a number of observations and material facts, whose meaning is so indisputable, that the most incredulous have been compelled to accept it in all its reality, when they have taken the trouble to see for themselves, and to judge conscientiously of what they have seen.

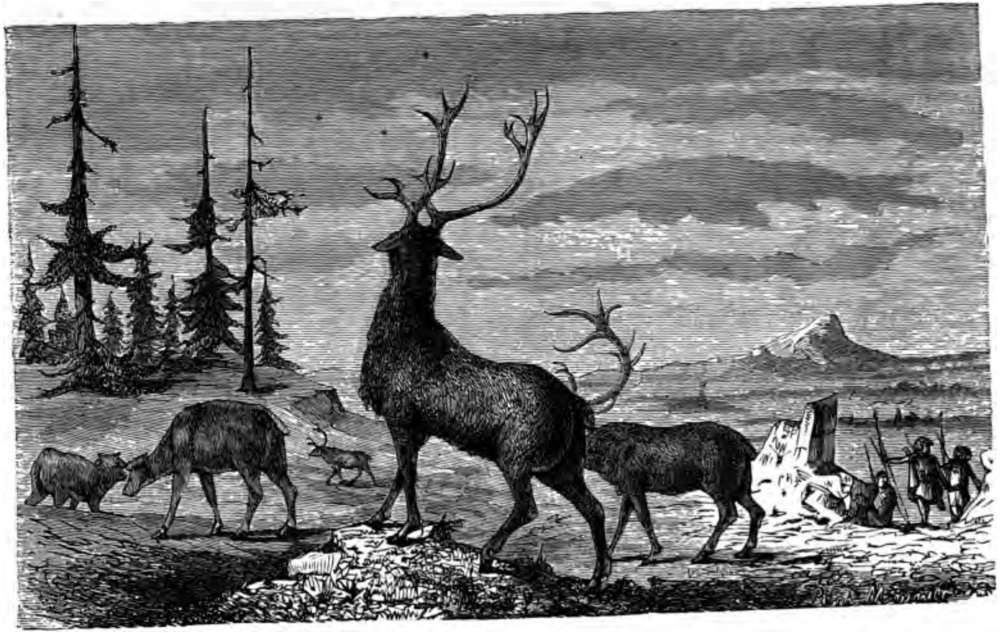
VI.

To the epoch of the mammoth duly succeeded that of the reindeer.

The proofs that man and the reindeer were contemporaneous in Southern Europe are of various orders. I shall indicate a few of them.

It is evident that the solitary fact of the mixture in a cavern of animal bones and the products of human industry, nay, even of human remains, would in no wise prove that man had lived at the same time as the animals with whose relics his own were thus associated. We can understand, indeed, that the bones of animals sunken in the soil for a longer or shorter period may be uncovered, either by the action of the waters, or by any other cause capable of disintegrating the deposit, and afterwards found mixed up with objects of a far more recent date. Men were long unwilling to admit that the ossiferous deposits of the caverns, and especially of those containing human remains, could possibly have had any other origin. They had necessarily been *disturbed* (*remaniés*). But there are cases in which the circumstances and conditions of the deposit render it impossible for any impartial inquirer to accept this hypothesis. And such a case occurs in the Grotto of the Eyzies (Dordogne), explored by Messrs. Lartet and Christy.

Here a heap of fragmentary bones, ashes, charcoal, splinters and blades of flint, weapons and tools carved



THE AGE OF THE REINDEER IN SOUTHERN EUROPE.

out of the bones of reindeer, completely cover the ground.

The whole has been aggregated and consolidated on the spot in the original condition of the deposit, and before any disturbing cause could operate, since *series of numerous vertebrae of reindeer, and piles of articulations with multiple pieces are found maintained and preserved exactly in their anatomical connection;* the long bones, and bones with the medullary cavities, are alone detached, and split or broken on an uniform plan, evidently with the view of extracting their marrow. These facts may be ascertained by any competent observer, for Messrs. Lartet and Christy were careful to remove this deposit in very considerable portions, and after having deposited the finest specimens in the Museum of Périgueux and in the collections of the *Jardin des Plantes* at Paris, they forwarded to various French and foreign museums fragments of sufficient size to enable the student to verify for himself the exactness of the observations which we have here recorded.

The second proof, incidentally mentioned in the foregoing narrative, is furnished by the condition of the bones of the reindeer: not a single long bone is entire; all are broken, and all broken in the same way; the diaphysis is constantly divided lengthwise, and only the heads of the bones are whole. As before stated, they have been obviously broken for the sake of their marrow. And in the same way every skull is fractured.

More: at the bottom of a great number of antlers you can see the notches made by the stone knife in removing the skin, and underneath the bones of the canons other transversal notches evidently made in cutting the tendons. It is known that, at the present day, the Eskimos remove these tendons, divide them, and convert them into thread, which they make use of in sewing their garments of skin, and for fabricating cordage of remarkable strength.

And now for a final proof, which Milne-Edwards considered decisive when first brought forward.

The Cavern of Bruniquel, in the department of the Tarn-et-Garonne, contemporaneous with the age of the reindeer, has furnished, in addition to a great number of antlers and bones, broken or carved, of weapons and tools found at a considerable depth, a bone on which has been drawn with the point of an arrow a couple of heads—one, of a horse, perfectly recognizable; the other, of a reindeer, not less distinctly characterized.

This drawing, says Milne-Edwards, whatever may be its date, can have been executed only at an epoch when the inhabitants of Bruniquel *knew* the animal, of which one of them has sketched the likeness; and they would be acquainted with it only if the reindeer lived where they lived, in the temperate regions of Europe; for it seems to me impossible to suppose that at a period so little advanced in civilization, the wild tribes dwelling on the banks of the Arveiron could have taken for the model of their rude ornaments an exotic animal confined to the circumpolar regions.

In addition to the ossiferous deposits of the interior of the bone caves, Messrs. Lartet and Christy have discovered in the Dordogne analogous accumulations of organic *débris* piled up against the great escarpments of the cretaceous limestones of that district, or, sometimes, simply sheltered by overhanging projections of rock.

These exterior deposits abound in stones shaped into tools or weapons, and in the broken bones of such animals as the horse, ox, ass, goat, reindeer, birds, and fishes. They have furnished some fine flints; particularly at the station of Laugerie-Haute, where a manufactory of spear-heads would seem to have been established. At Laugerie-Basse would seem to have existed a manufactory of weapons and tools made of reindeers' horns. A great variety of utensils has also been found, some of which are ornamented with elegant designs. Among other valuable treasure-trove, Messrs. Lartet and Christy describe the following:—

It is a first-rate specimen, they say, in which the true artistic sentiment is revealed by the skill of the artist in moulding animal forms, without too great a violence, to the necessities of a customary destination. This specimen is a dagger, or short sword, of reindeer's horn, of which the entire handle is formed by the animal's body; the hind-legs are extended in the direction of the blade; the fore-legs are folded easily under the belly; the head, whose muzzle is lifted up on high, forms, with the back and crupper, a hollow or cavity destined to facilitate the grasp of the weapon by a hand evidently much smaller than that of our European races.

The head is equipped with branching horns, which are set close to the sides of the neck (or haft), without in any wise rendering it difficult to hold; but the basilar antlers are suppressed. The ear is smaller than the stag's, and, in its position, more akin, too, to that of the reindeer. Finally, the artist has suffered to remain under the haft a thin projecting ridge, notched on the edge, and representing tolerably well the tuft of hair which we often find in this place in the male reindeer. It is to be regretted that this specimen should have been transmitted to us only in the condition of a simple sketch, as one may judge by the unfinished state of the blade, and by certain details of the carving which are barely indicated.

The station of Laugerie has also supplied a number of bone needles, very sharp at one end, and at the other perforated with a hole to receive the thread; a fact which explains to us why the pre-historic man removed the long tendons of the reindeer, as is shown by the notches made at the bottom of the cannon-bones.

In the same locality, and in the cavern of the Eyzies, an instrument has been found of quite a different kind, which deserves to be mentioned.

It is a first phalange, hollow in certain herbivorous ruminants, and which is found pierced artificially on the under surface, a little in front of its metacarpian or metatarsian extremity; by placing the under lip in the posterior articular cavity, and then blowing into the hole, you obtain a sharp sound analogous to that produced by a perforated key of average size. We can hardly doubt that this was a "call," usually employed by the hunting tribes; for up to the present time four examples have been met with, and three of these have been made with the phalanges of the reindeer, the fourth with the phalange of the chamois.

None of the flints wrought and chipped in the reindeer age, though thousands have been collected, exhibit the slightest trace of polish; but the cleavage is frequently remarkable for its great perfection.

THE CHASE DURING THE REINDEER EPOCH.

VII.

After the epoch characterized by the abundance of bones and reindeers' horns buried pell-mell with the humble products of human industry, in localities then inhabited by man, came, in the southern provinces of France—as, for instance, in the lower cavern of Massat in the Ariége, that of the Espelugues, and especially the cavern of Lourdes in the Upper Pyrenees—the age to which has been given the name of that savage bull, the aurochs, whose last survivors are now to be met with only in certain forests of Lithuania, Russia, and the Caucasus.

Like those of the reindeer in the preceding age, all the bones of the aurochs are broken.

Here terminate the paleontological ages, and the archaeological ages begin. The cave-bears and the primeval elephant have disappeared one after the other; the reindeer has migrated northwards; the same will be the case with the aurochs. But the domestic animals are about to appear. To stone chipped with infinite skill, but only chipped, the polished stone succeeds, as to the age of the polished stone will succeed the age of bronze, followed, in its turn, by the age of iron. Let us pass them briefly in review.

VIII.

To the age of polished stone belong the most ancient of those singular constructions discovered at first in Switzerland, and afterwards in France, Germany, and Italy, which have received the distinguishing appellation of *lacustrine dwellings*, and the immense *kitchen-middens* found in Denmark. We shall speak of the latter in the first place.

On certain points of the Danish coast our archaeologists have met with heaps of shells (oysters, mussels, cockles, and the like), fractured bones of mammals, *débris* of birds and fishes, mingled with objects of human industry. These heaps have been named *kjoekken-moeddings*, or "kitchen-middens;" that is, the remains of the kitchen.

They form elliptical hillocks, three to four hundred mètres in length, by fifty mètres and upwards in breadth, and three to four mètres in thickness. Here and there, in their midst, we meet with stoves, or cooking-places, constructed of smooth stones.

We are indebted to Sir John Lubbock for a description of the "kitchen-midden" of Meilgaard, which he carefully examined.

This heap of shells, one of the most considerable and interesting which has yet been discovered, is found at a short distance from the coast, near Grenaa, to the north-east of Jutland, in a magnificent forest of beeches called Aigt or Aglskov, the property of Herr Olsen, who, in his devotion to science, has given orders that the kitchen-midden shall not be destroyed, though the materials composing it are valuable as manure; and a portion of this very heap had been employed for this purpose before the true nature of the deposit had been indicated. Herr Olsen and his family received the visitors with cordiality, though they had arrived at his house without an invitation, and without even giving him any notice. He immediately despatched a couple of labourers to remove the *débris* which had accumulated since the last visit of archaeologists, so that on their arrival at the heap they found an entirely fresh surface to explore.

In the middle this kitchen-midden is about ten feet thick, but this thickness diminishes in all directions. Around the principal heap are collected smaller heaps of a similar nature. A thin layer of earth covers the shells, and trees grow in it.

A good section of such a kitchen-midden strikes with astonishment any person who sees it for the first time, and it is difficult to give in words an exact description of the spectacle. The whole bank is composed of shells; at Meilgaard oysters predominate; here and there a few bones are discernible, and, more rarely still, some instruments of stone or fragments of pottery. There is neither sand nor gravel, except at the summit and the base: in a word, this mass contains absolutely nothing which has not served for the use of man. The only exceptions I have been able to remark are some coarse pebbles of flint, but in very small numbers, which probably were fished up with the oysters.

No implement of metal is found in the kitchen-middens; and we may, therefore, consider them as belonging to the first age of polished stone.

From the explorations which have taken place we may reconstruct the fauna of this epoch, and we subjoin a list of the principal species:—

The urus, the stag, the reindeer, the kid, the wild boar, the wolf, the dog, the fox, the lynx, the wild cat, the seal, the otter, the beaver.

Among birds, the wild swan, the goose, the duck, the heathcock, the great penguin.

Among the refuse of fishes we have been able to recognize the herring, the cod, the dab, the eel.

The sole domestic animal was the dog.

We have first seen that the bones of the heathcock or moorfowl are included among the remains of birds found in the kitchen-midden. From the presence of this species we can form an idea of the probable antiquity of the deposits.

The moorfowl is specially partial to the young shoots of the pine, and has necessarily deserted Denmark since the epoch that the pine has ceased to flourish there.

Now, certain peat-fields, which the Danes name *skovmose*, or "tree-marshes," furnish us with an irrefragable proof that to the sombre forests of "murmurous pine," which covered Denmark in times so remote that tradition does not name them, have succeeded woods of oak (*quercus robur sessiliflora*), consisting of trees four to five feet in girth; that these have been replaced in their turn by forests of *quercus pedunculata*, which are likewise raised to-day from the local flora, for it is the beech which now constitutes the Danish forest.

These forests, then, have been thrice renewed since the men of the "kitchen-middens," with the assistance of a bone-pointed arrow and a domesticated (or trained) dog, brought down and captured the moorfowl; and, by means of rough stone and quick fire, wrought the primeval pine, where we still see to-day the marks of their laborious hands.

IX.

The first actual and authentic discovery of *Lake-Dwellings* dates from the winter of 1853–54, and took place on the Lake of Zurich, opposite Meilen. Thanks to an extraordinary subsidence of the waters, the workmen employed in throwing up an embankment came upon a number of piles and stakes standing erect in the mud, besides fuel, fireplaces, bones, and various implements. Dr. Ferdinand Keller, on hearing of this discovery, hastened to the spot, and in a very short time determined the nature of the constructions whose remains had been so curiously laid bare. From that moment a new field of exploration was open. The piles of Meilen, water-worn, and covered with a foot to two feet of mud, traverse a stratum, nearly twenty-two inches thick, of sandy clay, coloured black by the decomposition of organic matters. This stratum contains all the memorials enumerated above. It rests immediately on the bed, the *primitive* bed, of the lake; a bed into which the piles penetrate thirty feet and more.

These piles are arranged in lines parallel to the shore. They measure from four to five inches in diameter. Some are of oak, some of beech, others of birch and fir. Frequently they are made from trunks of trees split into three or four lengths. Their lower extremity has been fashioned to a point with the help of fire and axe. Many have been wrought with bronze hatchets; yet nearly all the tools found in the mud are of bone and stone. Axes of stone are likewise found, pebbles utilized as hammers, millstones, grindstones, heads of

LAKE-DWELLINGS IN SWITZERLAND

arrows and spears, knives and small saws of flint, and calcined slabs of sandstone which had been used for fireplaces. The implements in bone consist of chisels, bodkins, and needles. The bones, turned up in great numbers, are those of the aurochs, the saigu, the stag, the goat, the wild boar, and the fox, and, for domestic animals, the ox, the dog, and the sheep. A few human skeletons have also been discovered. We soon acquire the certainty that fishing and hunting were not the only sources of livelihood of the ancient inhabitants of Meilen; we learn that they were not unacquainted with agriculture, from grains of corn being preserved in the depository of the lacustrine mud.

We have dwelt at some length upon this discovery, because it was the first. Later ones have brought out facts confirmatory and elucidatory of what we have stated. The settlement of the Lake of Pfeffikon, in the canton of Zurich, was nearly two miles from the western, and three from the northern, bank. It occupied not less than one hundred and twenty-seven thousand square feet. That of Wangen, on the Lake of Constance, was composed of forty thousand piles. At the Lake of Moosedorf, in the canton of Berne, where you may see the notches on the piles made by the hatchets of stone, you will find fragments of pottery of a very coarse clay, in which the substance is mixed with minute siliceous pebbles, and barley seed agglomerated by carbonization. At the Lake of Zurich, slabs of *mollasse* utilized as fireplaces, millstones, and cordage and cables made with the bark of different trees. It is known that the platform on which the huts rested were formed of cross beams and timbers two to three inches thick, fastened upon the piles by wooden wedges; these wedges, the holes into which they were driven, as well as the square notches conspicuous on the piles, have all been made with tools of stone. On the Lake of Constance vessels have been found containing seeds of pine, nuts, and the pips of wild apples or pears. Quantities of pears and apples have also been discovered which had certainly been dried.

It is advisable we should here remark that the mode of life adopted by the people whose dwellings have been recovered at the bottom of so many lakes in so many different countries in Europe, singular as it appears, is by no means an isolated fact.

In New Guinea the Papuans build upon piles in exactly the same manner; and these piles, sunk in the sea at a certain distance from the shore, and parallel to it, support, at an elevation of eight to ten feet above the water, a flooring of round pieces of wood, which, in its turn, supports a row of square or circular cabins, constructed of planks and branches bound together, and covered with a conical roof. One or two narrow bridges lead to the shore. Exactly similar (allowing for the difference between a lacustrine and a maritime situation) were the habits of those Peonians of Lake Prusias (in modern Roumelia), whom Megabyzes could not conquer, and whose dwellings, acording to Herodotus, were constructed in the following manner:—

"Upon elevated piles, sunken in the lake, they prop up a firm built scaffolding, whose sole connection with the shore is by a narrow bridge. Each, upon this platform, has his own cabin, which is provided with a trapdoor opening upon the lake; and for fear their little ones should fall into the water, they tie them up with a cord round the foot. The lake is so full of fish, that by letting a basket down through the trap-door, they can draw it up full of spoil."

The dwellings of the Papuans, like those of the Peonians, are fashioned exactly on the same model as the lacustrine habitations of primeval Europe; and assuredly the condition of those who constructed the latter was very superior to the lot of the inhabitants of that aquatic city built in a creek of the River Tsadda, which, some years ago, awakened the astonishment of Dr. Baikie, the naturalist attached to the ship *Pleiad* on her expedition up the Niger. At the approach of the explorers, the inhabitants issued from their dwellings with the water up to their knees—a child was waist-deep. "We saw some of these huts," says the doctor, "which, if they are inhabited, compel their inhabitants to dive like beavers either for egress or ingress. We could never have conceived of reasonable creatures forming through taste a colony, so to speak, of beavers, and having the manners of the hippopotami and crocodiles which infest the neighbouring swamps."

The bones of the animals discovered in the ruins of the lake-dwellings of Switzerland have been determined by Professor Rütimeyer.

They belong to forty species—namely, twenty-eight Mammalia (mammals); six Aves (birds); two Reptilia (reptiles); four Pisces (fishes).

Among the mammals are found all the anciently domesticated animals: the dog, the pig, the horse, the goat, the sheep, and the ox.

What Rütimeyer has accomplished for the Fauna, Professor Oswald Heer has accomplished for the Flora; he has drawn up a list of the seeds, fruits, and plants of which men made use in pre-historic times. They comprise six-and-twenty items:—

Cereals: Wheat, spelt, six-rowed and two-rowed barley.

Fruits: Two varieties, one wild, one cultivated, of the apple; the pear, the cherry, and the plum.

Textile Plants: Flax.

Edible Forest Fruits: Walnut, beechnut, blackberry, raspberry, strawberry, blue prunella (wild plum?).

The water-chestnut (*trapa natans*), then employed as food, has now disappeared from the Swiss lakes, and the same may be said, with a slight qualification, of the dwarf water-lily (*nuphar pumilium*), for it is found at the present day only in one lake of the canton of the Grisons.

X.

Next to the age of polished stone came the age of bronze, to which belong the lake-dwellings of Western Switzerland, and in which the inhabitants of the future Cimbric Chersonese flourished, when wide forests of oak overspread their country; a fact we ascertain from the beautiful bronze implements found in the peat-bogs which the oak has filled.

Finally, to the age of bronze succeeded that of iron; the first iron age, of which the most recent or least ancient of the lake-dwellings—those of the Tène, for example, on the Lake of Neufchâtel—have preserved for us the monuments. The heads of spears and javelins, broad-edged axes, swords, scythes and sickles, all of iron, abound in them; the age knew but few ornaments, it was devoted to the useful: no longer the small-handed sword of the preceding age, but the sword, double-edged, two and a half to three feet long, and with a haft suited to the grasp of a man of ordinary stature.

The axe, too, is much larger and stronger than that of the bronze epoch, and the same may be said of the sickles, which are as large as our own. The spear-heads are nearly twelve inches in length. A robust and warlike people, then, have taken the place of the dwarfed and feeble race of the bronze age. They came as conquerors on the banks of the Rhine, bringing, along with their iron, red pottery ware, and money. The money—bronze simply melted in moulds—bears on one side the outline of a man's figure, on the other, the characteristic emblem of the Gauls, the horned horse. The peoples of the first iron age belong, then, to the great Gallic stock, and we are now in the presence of the Helvetians.

Between their arrival and the Roman epoch, a period of sufficient duration elapsed for the buildings which they raised on the lakes of Bienne and Neufchâtel—buildings of which they undoubtedly made use as magazines rather than as dwellings—to fall into desuetude, to disappear under the water of the lakes, and even to be effaced from human memory; for, as M. Desor has remarked, no Roman author, not even the most prolix, has mentioned them.

To sum up: the data already collected seem to justify our archaeologists in establishing a chronological succession of three periods in the history of primeval man—namely, the Age of Stone, corresponding in Scandinavia with that of the pine and the sessile oak; the Age of Bronze, partly corresponding with that of the oak; and the Age of Iron, corresponding with that of the beech. The duration of each of these periods we have no means of ascertaining; but the processes they involved in the gradual modification of the earth's surface could not have been hastily accomplished, and we may dismiss as fallacies all the calculations of chronologists which would limit the antiquity of man to some six or seven thousand years.

It is sometimes supposed that the antiquity of man is a theological question, and that the generally received chronology is mixed up with Scriptural considerations. For such a supposition there is no warrant. The narrative in Genesis is confined to a particular region of the earth; and nothing seems more certain than that the Noachian Deluge was a flood of partial operation, confined to the countries lying at the foot of the Caucasus.

APPENDIX.

I.—ON SOME ANIMALS WHICH HAVE RECENTLY DISAPPEARED.

FROM numerous data established in the preceding pages, we see that the extinction of species was continued long after man's appearance upon earth. *Why* this extinction took place, why it is still taking place, whether the Darwinian theory of "natural selection" and the "survival of the fittest" furnishes a satisfactory explanation of a fact which we cannot but call remarkable, it is not our province in these pages to consider.

But this is certain: the cave-bear, the cave-hyena, the *elephas primigenius* or mammoth, the *rhinoceros tichorhinus*, covered with a coat of woolly hair like the mammoth, and the *hippopotamus major*, have been struck out of the list of living animals since man first dwelt in Europe.

Has the same fate befallen the cave-tiger?

We cannot answer this question without some degree of hesitation. M. Lartet has put forward the opinion that the lions which, in Thessaly, attacked the beasts of burden attached to the host of Xerxes, belonged to this genus; and Dr. Falconer thinks that the great *felis* of Northern China and the Altaï Mountains will be the living representative of the *felis spelaea*.

If these suppositions are correct, the great cave-tiger ought to be placed in the category of species whose geographical limits have been gradually contracting since the Post-Tertiary Epoch. To this category belong the musk-ox and the reindeer, which are no longer met with except in the Arctic regions; and the aurochs, whose race would long ago have been extinct had it not been the object of particular care.

These phenomena are ancient; but analogous phenomena have been constantly occurring since historic times, and are occurring under our very eyes. Thus, in Great Britain, the badger and the heron, to take but these two examples, are slowly disappearing; and the famous white cattle of Scotland are confined to one or two localities, where they exist under artificial conditions. As civilization extends its supremacy over the globe, the range of the beast of prey is more and more confined. The lion has been driven into the recesses of African solitudes; the wolf, long expelled from England, is being yearly pushed back further and further from the frontiers of civilized life; and it is not extravagant to suppose that before many generations have passed away the wild beasts of the forest and jungle will have ceased to exist, except in our museums and menageries, or the remotest corners of the untamed earth.

Among animals that have recently disappeared we may mention more particularly the *Dinornis* and the *Dodo.*

When the Maoris, some six or seven hundred years ago, effected a landing in New Zealand, they found the island peopled with immense flocks of the dinornis and the palapteryx. As they found there no other game, they naturally devoted themselves to the chase of these gigantic birds. The mode of hunting adopted is described in many Maori poems, and also the feast of the hunters on their return from these expeditions, just as the banquets of the Scandinavian hunters are depicted in the old Norse sagas. In the vicinity of ancient encampments piles of bones have been discovered, attesting the accuracy of these descriptions. It is easy, therefore, to account for the extinction of the moa or dinornis and its gigantic companion: it is the natural result of the war of extermination undertaken by man.

The disappearance of the dodo is probably of still later date.

In 1598, some Dutch seamen who were wrecked on the Mauritius, an island previously uninhabited, encountered a great number of stupid and unwieldy birds, equally incapable of defence or flight. These were the dodos. Impelled by hunger—for the flesh of the dodo was most unsavoury—the sailors killed them in great quantities. The same course of slaughter was pursued by other seamen who visited the island, and especially by the colonists who founded a settlement there in 1644. When Leguat visited the Mauritius in 1693, not a single dodo was in existence. The species had disappeared between 1681, the date of the last reference to living individuals, and 1693. Even in these last twelve years it was only known by the imperfect remains preserved in various museums, and by a drawing taken from an individual which had been brought alive to London in 1638. Recently, however, a considerable number of the bones of the extinct bird have been found embedded in the turf and peat-beds of the island. Our naturalists are not agreed, nevertheless, as to its proper affinities; and while some include it among the pigeons, others are of opinion that it was allied to the vultures. Between the *Columbidae* and the *Vulturidae* there would certainly seem to be a sufficiently wide range of choice!

These facts, which we might easily multiply—which, indeed, almost every reader can multiply for himself from personal observation—demonstrate that the extinction of species is a continual and normal fact, which operates without the intervention of any of those cataclysms, or terrible revolutions, to which a certain school of geologists had recourse in explanation of every difficulty,* and by the single fact of vital concurrence; whence it follows that between living and extinct species no line of demarcation can possibly be drawn. There is no epoch in the world's history at which a former creation of animal and vegetable life was blotted out, and an entirely new creation called into being.

---

* Three schools of geology have had their respective disciples: that of *Catastrophism*, now counting but very few pupils; that of *Transitionism*, so ably supported by Sir Charles Lyell; and that of *Evolutionism*, of which Professor Huxley is a prominent exponent. The latter will probably receive the allegiance of the geologists of the future.

II.—BRITISH FOSSIL MAMMALIA AND BIRDS.

To be ignorant of the paleontology of our own island is not less disgraceful than to be ignorant of its history; and, in truth, without some knowledge of its leading facts, we shall not be able to appreciate its early geological conditions. The subject, however, is too wide and too rich to be discussed in these pages, and we must refer the reader to the distinguished authorities who have treated of it with a fulness that leaves little to be desired, and among whom Professor Owen is deservedly famous; confining ourselves here to a brief enumeration of the fossil Mammals and Birds which anciently dwelt within the limits of the British Isles.

QUADRUMANA (APES AND MONKEYS).

As early as 1830, in his first edition of the "Principles of Geology," Sir Charles Lyell had inferred, from the presence of crocodiles and turtles in the London Clay, and of Tropical products in the deposits of the Isle of Sheppey, that at the period when our older Tertiary strata was formed, the climate was hot enough for the quadrumanous tribe. No vestige of ape or monkey had, however, been discovered, and it was a general belief that the Quadrumana were either contemporaneous with man in the order of creation, or preceded him but a very short time.

But in 1839 Mr. William Colchester, by the side of the river Deben, and about a mile from Woodbridge in Suffolk, came upon some fossil remains which Professor Owen identified as those of a monkey; and the species thus strangely discovered he designated *Macacus Eocaenus*, the Eocene Monkey or Macaque.

VESPERTILIONIDAE (BAT TRIBE).

The ancient Bats seem to have been entirely confined to cave localities, and to have borne very close affinities to existing species. We find the *Vespertilio noctula*, or Great Bat of Pennant, and the *Rhinolophus ferrum-equinum*, or Greater Horse-shoe Bat, have been satisfactorily determined.

But in lower and older geological formations, such remains as may with any probability be referred to the Cheiropterous order cannot, says Professor Owen, be identified with known existing species.

INSECTIVORA (TALPA, OR MOLE).

The fossil remains of Moles belong, with one exception, to species living in Great Britain at the present day; as the Common Mole (*Talpa vulgaris*). An extinct species, *Palaeospulux magnus*, has been discovered in the lacustrine deposit at Ostend, near Barton, on the coast of Norfolk; and this water-mole was of unusual dimensions.

The ancient or fossil *Shrews* (*sorex*) have offered no indication of species distinct from those now existing in Great Britain.

INSECTIVORA (AMPHITHERIIDAE).

The *Amphitherium* was an insect-eating quadruped. The two principal species are the *Amphitherium Prevostii*, and *Amphutherium Broderipii.*

MARSUPIALIA (ENTOMOPHAGA).

Genus *Phascolotherium*, closely akin to the marsupial genera (such as the kangaroo and wombat), now confined to Australia and Tasmania.

Genus *Didelphis* (or Opossum).

CARNIVORA (URSIDAE).

The Brown Bear (*Ursus Arctos*) lived in the mountain districts of Scotland as late as 1707. The Tree-Bear and the Great Cave-Bear (*Ursus spelaeus*) are fossil genera. Another cave-haunting bear was the *Ursus priscus*, the contour of whose skull was less elevated than in the brown variety. Remains have been discovered at Kent's Hole, near Torquay; in the Oreston quarries, near Plymouth; at Kirkdale, in Yorkshire; at Paviland, in Glamorganshire; and Durdham Down, near Bristol.

In the caves at Torquay have also been discovered the remains of a Badger (*Meles taxus*), not distinguished from the existing British species which is now so rapidly disappearing. It must have owed its safety, says Professor Owen, from the formidable contemporary beasts of prey, to the same cautious concealment and nocturnal habits which still continue to preserve the harmless species amidst the more numerous and dangerous class of enemies which has arisen from the increasing population of a civilized country.

CARNIVORA (MUSTELIDAE).

The fossil Pole-cat (*Putorius vulgaris*) does not seem to have been distinguished in any important character from the living species. The ancient British ermine (Dr. Buckland's "fossil weasel") may, in like manner, be identified with the existing Stoat (*Putorius ermineus*), though it seems to have been of much larger size.

The *Lutra vulgaris*, or Common Otter, has also survived the geological changes of our island, and furnishes us with a living link between the fauna of the present and the past.

"Whatever revolutions," says Professor Owen,* "the surface of this island has subsequently undergone, the otter, as a species, still survives. The beaver was its associate in the ancient rivers of England, from the Pliocene era down to the historical period, when this large herbivorous rodent finally disappeared, according to some naturalists, in the year 1188. The intimate dependence of the beaver upon the bark of trees for food, and upon the wood for the fabrication of its dams and dwelling-place, makes its extirpation a very obvious consequence of the clearance of the forests of England.

"The otter, independent of the vegetation which of yore overshadowed the rivers it haunted, burrowing in their banks for shelter and concealment, and preying exclusively on their scaly inhabitants, has been comparatively little affected by the changes which cultivation has produced in the lands through which those streams now flow."

CARNIVORA (CANIDAE).

The existence of the Wolf, or *Canis Lupus*, dates from a period anterior to the deposition and dispersion in Great Britain of what is called the superficial drift. Its remains have been found in all our bone-caves.

The same may be said of the *Canis familiaris*, or Dog, and the *Vulpes vulgaris*, or Common Fox.

---

* Owen, "British Paleontology."

CARNIVORA (VIVERRIDAE).

The *Hyaena spelaea*, or Cave-Hyena, was discovered by Dr. Buckland at Kirkdale in 1821. The remains were so numerous that the great geologist attributed them to no fewer than two or even three hundred individuals. The cave seems to have been used as a den by hyenas for a considerable period, and they had dragged into its recesses the carcases of numerous animals, whose bones were intermingled with their own.

Fossil remains of hyenas have since been found in various localities.

CARNIVORA (FELIDAE).

The *Felis spelaea*, or Great Cave-Tiger, is another beast of prey whose former existence in Britain has been revealed to us by the rich ossiferous deposits at Kirkdale, Oreston, and elsewhere. It was at least as large as the largest African lion or Bengal tiger, but had more powerful limbs and larger paws.

Felis Pardoides (Owen), discovered at Newbourn, near Woodbridge; a carnivorous mammal akin to the leopard.

Felis catus, or Wild Cat. Of this species our household cat is probably a domesticated variety.

Machairodus, or *Ursus cultridens*.

Machairodus latidens, an extinct feline animal, as large as the tiger, and furnished with teeth of singularly destructive power. "It is hardly conceivable," says Owen, "that man could have lived in a land exposed to the ravages of three such terrible carnivora as the tiger, bear, and machairodus."

RODENTIA (CASTORIDAE).

Trigontherium Cuvieri, or Cuvier's Gigantic Beaver; a species nearly allied to, but considerably exceeding in size, the largest of living beavers. We may judge of its probable proportions from the fact that its incisive teeth measured seven inches in length.

Castor Europaeus, or European Beaver; identical with existing species.

Arvicola amphibia, or Water-Vole; identical, apparently, with our common water-rat.

Arvicola agrestis, or Field-Vole.

Arvicola pratensis, or Bank-Vole; identical with Yarrell's *Arvicola riparia*.

RODENTIA (MURIDAE).

Mus musculus, or Mouse; identical with existing species.

RODENTIA (LEPORIDAE).

Lepus timidus, or Hare; resembled the Lepus Hibernicus, or modern Irish Hare.

Lepus cuniculus, or Rabbit; identical with existing species.

Lagomys spelaeus, or Cave-Pika; a species of rodent no longer existing in the British Isles or on the European Continent. The pikas, or tailless hares, are now confined to Siberia, the Himalayas, and some parts of North America.

PACHYDERMATA (PROBOSCIDIA).

Elephas primigenius, or Mammoth; formerly abundant in England.

Mastodon angustidens, or Narrow-toothed Mastodon; a genus which preceded the appearance of the mammoth.

PACHYDERMATA (TAPIROIDA).

Coryphodon Eocaenus, or Eocene Coryphodon; a tapiroid pachyderm, forming a link between the proboscidian and tapiroid families of the pachydermata. Though a third larger than the largest tapir of South America, its habits were probably the same; its food vegetable, consisting of the wild fruits, buds, and shoots abounding in the dense primeval forests.

Coryphodon, or *Lophiodon;* another extinct genus of tapiroid pachyderms.

Lophiodon, or *Palaeotherium;* extinct genus.

Lophiodon minimus, or Dwarf Lephiodon; extinct genus.

Palaeotherium magnum, or Great Palaeothere; an extinct genus, resembling the living tapir.

Palaeotherium crassum, and *Palaeotherium minus*.

PACHYDERMATA (RHINOCEROS).

Rhinoceros tichorhinus, or Tichorhine two-horned Rhinoceros; extinct.

Rhinoceros leptorhinus, or Leptorhine two-horned Rhinoceros; extinct.

PACHYDERMATA (SOLIDUNGULA).

Equus fossilis, or Fossil Horse; "a species equalling a middle-sized horse, and one of the size of a large ass or zebra, were the associates of the mammoth, rhinoceros, and other extinct quadrupeds."

Equus plicidens, a fossil species.

Asinus fossilis, or Fossil Ass, or Zebra.

PACHYDERMATA (HIPPOPOTAMUS).

Hippopotamus major, or Large Fossil Hippopotamus. "The hippopotamus," says Sir Charles Lyell, "is now only met with in rivers where the temperature of the water is warm and nearly uniform; but the great fossil species of the same genus certainly inhabited England when the testacea of our country were nearly the same as those now existing, and when the climate cannot be supposed to have been very hot."

PACHYDERMATA (CHOEROPOTAMUS).

Choeropotamus Cuvieri, or Cuvier's Choeropotamus; a quadruped resembling the peccary, but about one-third larger.

PACHYDERMATA (HYRACOTHERIUM).

Hyracotherium leporinum, or Leporine Hyracothere; distinct from any living mammal, but akin to the choeropotamus.

Hyracotherium cuniculus, or Rabbit-like Hyracothere.

PACHYDERMATA (SUS).

Sus scrofa, or Wild Hog; identical with existing species.

PACHYDERMATA (ANOPLOTHERIDAE).

Anoplotherium commune, or Common Anoplothere; a hoofed quadruped, of herbivorous habits, and probably amphibious.

Though it cropped grass like a horse, it took to the water for shelter from its enemies, the carnivores.

Dichobunum cervinum, or Cervine Anoplothere; extinct.

RUMINANTIA (CERVUS).

Megaceros Hibernicus, or Gigantic Irish Deer (Fossil Elk of Ireland); extinct. The dimensions of its antlers are computed at ten feet ten inches in a straight line from tip to tip; length of each, from the base to the extreme tip, five feet two inches. Weight of skull and antlers, varying from seventy to ninety pounds.

Strongyloceros spelaeus, or Gigantic Round-antlered Deer; probably the largest of our extinct English cervine animals.

Cervus (*Strongyloceros*) *elaphus*, or Red Deer; species still in existence in the Scottish Highlands. It was contemporaneous with the cave-hyena and the mammoth.

Cervus Tarandus, or Reindeer.

Cervus Dama, or Fallow-deer.

Cervus Bucklandi, or Buckland's Fossil Deer. This genus, unlike the two former, has no living representative. The first specimen was found in the bone-cave of Kirkdale.

Cervus Capreolus, or Roebuck; identical with the existing species, now limited, in Britain, to the Scottish Highlands.

RUMINANTIA (CAPRA).

Capra Hircus, or goat; identical with existing species.

RUMINANTIA (BOVIDAE).

Bison priscus, or Great Fossil Aurochs; no longer found in Britain, but still preserved, in limited numbers, in the forests of Lithuania.

Bos primigenius, or Great Fossil Ox; the *urus*, or aboriginal wild ox described by Caesar as formerly inhabiting the dense forests of Germany. It differed from the aurochs, or *bison*, in the greater length of its horns; and from the common bull, which it resembled in colour, form, and general aspect, by its huge stature. Unlike the aurochs, this genus is wholly extinct.

Bos longifrons, or Long-fronted, or Small Fossil Ox; a smaller species, which may not improbably have been the origin of our domestic herds, though smaller than these.

CETACEA (DELPHINIDAE).

Phocaena crassidens, or Thick-toothed Grampus; akin to the porpoise genus of the dolphin tribe.

CETACEA (MONODON).

Monodon monoceros, or Narwhal.

CETACEA (PHYSETERIDAE).

Physeter macrocephalus, or Cachalot, or Sperm Whale.

CATACEA (BALAENIDAE).

Cetotolites, or Fossil Ear-bones of Whales, have been discovered in the Red-crag at Felixston, in Suffolk.

Balaenodon Physaloides, or Cachalot-like Balaenodon; extinct.

BRITISH FOSSIL BIRDS.

Cimoliornis Diomedeus, or Long-winged Bird of the Chalk; allied to the albatross, and equal to it in size.

Lithornis Vulturinus, or Vulture-like Lithornis.

Halcyornis Toliapicus, a bird of the Kingfisher genus.

Also, species of the *Ardeidae*, *Passeres*, *Corvi*, *Columbidae*, *Falcones*, &c.

III.—PRE-HISTORIC MAN IN SCANDINAVIA.

BY A. DE QUATREFAGES.

(*From the* "*Revue des Deux Mondes*," *vol.* lxxxvi., *pp.* 973–978.)

THE various memorials of early ages which we find in the marshes of Denmark, have not only been preserved there, often in the most remarkable manner, but classified. Owing to the gradual development of the peat, each of these deposits has preserved its own line of immersion, has remained separate from those which had preceded and those which have followed it. These marshes have thus become, to a certain extent, natural museums, in which the tables (*tablettes*) are represented by layers of peat. From this point of view the *forest-marshes* (*scovmoses*) possess an exceptional interest. Generally much deeper, nearly always less extensive than the *meadow-marshes* (*kjaermoses*) and the *heath-marshes* (*lyngmoses*), they lend themselves better than either to detailed investigation. And, finally, the forest vegetation, to which they owe their name, is replete with significant teaching. I had long been acquainted with their reputation, and was resolved not to quit Copenhagen without seeing them with my own eyes.

On a cold and rainy day in September I therefore started for the marshes of Rudersdal, accompanied by my friend M. Steenstrup. On the road we visited some others, and in a few hours, thanks to the information given me, I was able to establish one by one the essential facts. The reader will easily understand that in the interest of the study I forgot the cold and mist, against which, moreover, my scientific and amiable cicerone had provided us with due resources.

The *scovmoses* present themselves under the form of excavations of a very circumscribed character, from thirty to forty feet in depth, more or less irregular in form, and wrought in a formation of the glacial epoch, whose pebbles and rocky fragments are of Swedish origin. As the result of personal observations in Iceland, M. Steenstrup proposes a very plausible explanation of the formation of these cavities. He thinks that great masses of ice, accidentally embedded in the mud of that epoch, have melted where they lay, leaving, as it were, the mould which they had occupied. Rain, and other atmospheric agencies, completed the cavity in which the swamp has since been formed. The latter rests upon a bed of clay, presenting no trace of organic *débris*, and evidently produced by the first washings of the sides. Above it lie several peaty layers of a very distinct composition: and, first, a bed of peat, in which the microscope reveals various indeterminable fragments of the most inferior vegetables; then a second stratum, in which can be detected some mosses of higher organization, and robust forest pines, but stunted and thin, as if they had vegetated on an uncongenial soil; and, lastly, we come to heaths, mingled with birches, elms, and hazels.

Such is the composition of the *peat-bog* properly so called, or *central region* of the *scovmose*. The slopes of the cavity must be separately considered. They constitute what has been justly called the *forest region*. And, in fact, these slopes or sides have been the seat of a rich arborescent vegetation, which dates from the appearance of the mosses. Finding in the glacial soil a peculiarly appropriate site, it has largely developed, and it also presents a succession of essences well worthy of attention. And first arose the forest-pine alone, whose nearest trunks and those of largest size were to form magnificent forests. At a later date appeared the oaks, which soon reign in their turn, and own no divided sway. These trees, very seldom attacked by the hand of man, grew and flourished and perished in their place. When they fell, it was naturally in the direction of the marsh, and their aged trunks, immersed in its preservative waters, are still found in the peat, frequently intertangled, and across each other, as if skilful woodmen had directed their fall towards the centre of the *scovmose*. By being superimposed upon one another naturally, they have divided the peaty mass into terrace-like strata, and introduced some elements of relative computation into the chronology of these remote ages.

The beech, which is now the national tree of Denmark, and of which the royal park at Copenhagen possesses such splendid specimens, is altogether absent from the *scovmoses*. On the other hand, the oak has almost wholly disappeared from this country. As for the pine, not even the oldest legends mention it. All the trees of this species which exist in our days are of recent and artificial introduction. Very probably the hand of man has had nothing to do with the succession of these forest essences. Scanty and semi-civilized populations might destroy, but would not know how to replant forests. We have here, then, an example of those spontaneous changes of the flora, of those invasions of plants, which botanists have so frequently ascertained. Thus we are able, through the vegetable kingdom, to establish in the past of Denmark chronological divisions analogous to those which the animal kingdom has furnished for France. In summing up his admirable researches on the faunas contemporaneous with man, M. Lartet has divided the pre-historic times of France into four epochs: that of the cave-bear, that of the mammoth and rhinoceros, that of the reindeer, and that of the urus. In Denmark we may, in like manner, define the ages of the pine, the oak, and the beech; the two first entirely vanished, the third still in its prime.

However, it is from human industry that the Scandinavian physicists have borrowed their chronological denominations, and it is easy to understand why they have done so. Archaeology, the starting-point of their researches, has remained the goal of their studies. They ask nothing more of the natural sciences than to assist them in labours which preserved in other respects their primitive character. Evidently they were unable to go in search, in an order of ideas and of accessory facts, of the fundamental divisions of what was for them essential. On the contrary, by studying the tools and weapons left by their ancestors, they have found that the workmen of the old ages employed successively three kinds of materials more and more adapted to satisfy all the wants of man; they have ascertained that civilization modified and expanded itself proportionally. They have thus been led to recognize the Ages of Stone, Bronze, and Iron. These designations, and the ideas which they suggest, were at first received with mistrust, and by many scientific men were openly rejected. They are now universally accepted, and no one is ignorant of their meaning. Moreover, they carry us far back into the past. The Age of Iron marks the dawn of historic times, the two others belong to the pre-historic period.

The researches made in Denmark have enabled us to establish a certain coincidence—undoubtedly fortuitous, but not the less curious—between the ages defined by characteristic vegetation, and those distinguished by the progressive development of human industry. Man has left no trace of his existence in the lowest strata of the peat marshes, the clay, or the amorphous peat; but he appears at an early date in the midst of the pine forests of the *scovmoses*. At that time, though occupying a permanent habitation, he is exclusively a hunter and a fisher; he fabricates his utensils and weapons rudely and simply out of stone and bone. He clothes himself undoubtedly with the spoils of the chase; he has no other domestic animal than the dog. He feeds in the same manner as the modern Eskimos—that is, he uses all his teeth to crush or pound his food, the incisors and canines simultaneously with the molars; so that almost at the first glance we can recognize a jaw of this epoch. Though placed under unfavourable conditions, we see him flourishing and developing to a certain extent. The arts make progress: the stone, at first so roughly wrought, assumes under his hand more delicate and distinct outlines; is polished and sculptured with remarkable skill. There is a flint dagger in the *vitrines* of Copenhagen, with a broad elongated blade, a double edge, a handle indented with little notches, which our most skilful workmen would certainly find it difficult to reproduce. At the same time, it appears the population were renouncing, at least in part, the life of a hunter. They planted themselves in the most fertile districts of their territories; and M. Worsaee considers it probable that before the expiry of the Age of Stone they had commenced the cultivation of agriculture, and were owners of flocks and herds.*

The Age of Bronze replaces that of Stone almost at the same moment that the oak takes the place of the pine. The man of this epoch is evidently superior to his predecessor. If as yet he is ignorant of the art of welding metals, if he knows neither iron nor silver, he can handle gold and bronze with a real ability. He melts the latter to make his weapons, offensive and defensive, his instruments, his utensils, his tools, his martial trumpets. In the same manner he melts the former to obtain a supply of ornaments or massive vases; but he also understands the art of beating it out into thin plates and fashioning it with the hammer, to decorate his bucklers, his helmets, his swords, or of drawing it into thin threads, with which he weaves his rings and bracelets.

These various articles are often remarkable for their elegance of design, and their ornamentation is in the purest taste, being generally borrowed from geometrical lines.

The man of the Bronze Age, moreover, multiplied his auxiliaries.

---

* "The Antiquities of South Jutland or Sleswick" (Journal of Royal Archaeological Institute of Great Britain and Ireland, 1866).

We find him attended by a dog superior in breed and training to the dog of the earlier epoch; sheep furnish him with a rude kind of woollen clothing; he is lord of many oxen, goats, swine, and horses. It is true that these domestic animals are still characterized by their smallness and their slenderness of limb. They all belong to inferior races; but we cannot deny that the man of the Bronze Age has made a very considerable step in advance. Without having passed through the intermediate stage of the shepherd, he appears to have started as an agriculturist and a merchant.*

To the oak succeeds the beech, and almost at the same time the Age of Iron begins in Denmark. No transition is here visible between the two ages. We pass suddenly from the sword moulded in bronze to the damascened sword, a masterpiece of iron forging.† From this moment also date the most ancient alphabetical signs discovered in Scandinavia. The two great elements of modern civilization in the world of thought and in the world of material facts penetrate simultaneously into those northern regions. They are accompanied by glass and silver, both unknown to the two preceding ages. The races of domestic animals are perceptibly ameliorated. The horse is not only employed as a charger, he is harnessed, and used as a beast of draught. Agriculture develops itself; commerce enlarges and extends. It was this, undoubtedly, which, in the first centuries of our era, introduced Roman money into Denmark, and, at a later date, the Byzantine. The useful and agreeable arts—the arts of utility and pleasure—follow the same progression. Woollen stuffs are admirably perfected; large and well-built ships take the place of simple canoes or fishing-boats. The art of ornament derives its inspiration from living Nature, and reproduces plants, animals, and the human form, with attributes sometimes fantastic. All things seem combining to prepare that strange epoch when the Scandinavian north should overflow, as it were, in all directions; when its vikings should ravage the remainder of Europe, while awaiting the hour of permanent settlement, and extend their conquests even to the New World, as a rival of the Thomsons and the Nilssons has recently discovered.*

---

* Worsaee, "Antiquities of South Jutland or Sleswick" (*ut antè*).

† Engelhardt, "Guide Illustré."

The ages of which we have been speaking have nothing absolute or definitive, and must always be considered from a local and relative view-point. They nowhere coincide in Europe, in the world, not even in countries lying at no great distance from one another. In their earliest struggles with the Romans, the Gauls handled iron weapons; and yet it was not until the third century of our era that this metal appears to have penetrated into Denmark. In these northern regions, the Age of Bronze had previously prevailed. When did it commence, and especially to what date are we to refer the opening of the Stone Age—or, in other words, the appearance of man in this country? On these points history is silent. An attempt has been made to supply this silence by calculations based on the observation of natural phenomena. M. Steenstrup has endeavoured to estimate the time requisite for the formation of the peat-beds accumulated in the marshes. He thinks that at least four thousand years would be necessary to provide for a thickness of twenty feet; but he himself acknowledges that he may be mistaken to the extent of four or eight thousand years. I will add that the error may be more considerable still. The numbers furnished by various authors as representing the annual increase of the peat vary in the ratio of one to twenty. In the face of such remarkable discrepancies, it is impossible even to think of calculating an average.

And so far we cannot place any greater confidence in other processes of computation employed by different authors. Yet it would be a mistake to abandon this class of investigations. When we are better acquainted with a greater number of facts, and can control them by one another, we shall be able undoubtedly to interpret them. We must not give up all hopes of determining—at least approximately—the number of years which separates us from the epoch when the present economy was established on the surface of the globe. It is certain, at all events, that the Stone Age of Denmark is posterior to that initial epoch. No great revolution has convulsed the soil since man took possession of it. We meet with no traces of the great animals which occupied the other parts of Europe. The man of the Kjoekkenmoeddings is, therefore, of a much later date than the inhabitants of the caves of France and Belgium.

---

* Rafn, "Antiquitates Americanae."

NOTE.

THE MOAS OF NEW ZEALAND.

(*Page* 187.)

WE read in the *Pall Mall Gazette* (July 1871), that some faint hope is entertained that, in the mountainous regions of New Zealand, a few specimens of the gigantic moa may still exist, and we trust that, if any should be found, they will be immediately entrusted to the Aborigines Protection Society. Dr. J. Hector, F.R.S., has lately acquired possession of part of the skeleton of one of these birds which have been supposed to be extinct, and infers its recent existence from the fact that feathers still adhere to it. He believes that in the inland district of Otago, where the grassy plains and rolling hills were covered with a dense scrub, the giant wingless birds of New Zealand to a late period lingered. Bones are to be found in great profusion in this region; and Dr. Hector himself observed, in 1863, upon one of the flat-topped mountains near Jackson's Bay, numerous well-beaten tracks through the scrub which could have been made (though not then used) only by some very large indigenous bird. The south-west district of Otago is even at the present time imperfectly known, and we may owe its complete survey to some enterprising ornithologist in search of the gigantic moa.

TABLE OF FRENCH MEASURES.

LENGTH.

	English Inches.	Eng. Feet.	Eng. Yards.
Millimètre	.03937079904		
Centimètre	.3937079904		
Décimètre	3.937079904		
Mètre	39.3707904	3.2808992	1.093633
Décamètre	393.707904	32.808992	10.93633
Hectomètre	3937.07904	328.08992	109.3633
Kilomètre	39370.7904	3280.8992	1093.633
Myriamètre	393707.904	32808.992	10936.33

N.B.—The mètre is the one two-millionth part of a quadrant of the meridian.

CAPACITY.

The Litre is the unit of the present French measures of capacity, both dry and liquid. In volume it is equal to a cubic décimètre, or to 0.2200967 British imperial gallon. Ten litres make a *décalitre* (20.20096 British imperial gallon); 100, a *hectolitre;* 1000, a *kilo-*

litre. The *hectolitre* is the common measure for grain, and equals 0.3439009 British imperial quarter, or nearly 2¾ imperial bushels.

WEIGHT.

	Grains Troy.	Lbs. Avoirdupois.	Cwt.
Centigramme	.1543234	.0000220462	
Décigramme	1.543234	.000220462	
Gramme	15.43234	.00220462	
Décagramme	154.3234	.0220462	
Hectogramme	1543.234	.220462	
Kilogramme	15432.34	2.20462	
Myriagramme	154323.4	22.0462	.19684
Quintal	1543234	220·462	1.9684

INDEX.

ACEROTHERIUM, the, described, 129, 130.
Adams, Professor, his researches, 162, 163.
Agassiz, M. Louis, description of fossil fishes by, 237, 238.
Ages, the four paleontological, 282.
Ammonites, the, general characteristics of, 258–261.
Amphitherium, the, 315.
Ancylotherium, the, physical characteristics of, 71–73.
Andrias, the, a real salamander, 232; when and where exhumed, 232; Camper's description of, 235, 236.
Animalcule, its work beneath the ocean, 264, 267.
Animals which have recently disappeared, enumeration of, 311–313.
Anoplotherium, the, reconstructed by Cuvier, 119; characteristics of 120, 121; the Xiphodon gracile, 122, 123.
Anoplotherium commune, the, 319, 320.
Antique World, our vague conceptions of, 43–45; our materials for its imaginary reconstruction, 45, 46; these are supplied to us by geology and paleontology, 46, 47.
Antiquity, what it means geologically, 21–23.
Anthracotherium, the, described, 127.
Apes, fossil, recent discoveries of, enumerated, 31, 32; anthropomorphic apes described, 33, 34; discovered in the upper Tertiary formation, 34–40.
Archaeopteryx, the, discovery of, 194; an account of its remains, 195.
Atolls, or coral islands, processes of formation of, 264.
Aurignac, discoveries of fossil cave-bears at, 55, 284–286.
BADGER, the, fossil remains of, 315, 316.
Bears, fossil, found in various European countries, 51, 52; the cave-bear described, 52–54; discoveries at Lherm, 54, 55; at Aurignac, 55; on the ursus arctos and ursus priscus, 315.
Beaumont, Elie de, his sensational theory of creation, 16.
Belemnites, the, general characteristics of, 255–258.
Bianconi, the Italian anatomist, on the "bird of Madagascar," 193.
Birds, the paleontology of, an infant science, 175, 176; its slow progress, 177, 178; rarity of fossils of, 178, 179; the "bird of Massachusetts," 181, 182; British fossil birds, 183, 184.
Bison priscus, 320.
Boar, the Erymanthian, legend of, 116; relics of sus Erymanthius, 117, 118.
Bonaparte, Prince Charles, on the paleontology of birds, 175, 176.
Bos primigenius, the, 320.
Bourgeois, the Abbé, quoted, 281, 282.
Britain, Great, animals which have disappeared from, 312.
British fossil birds described in detail, 183, 184, 321.
British fossil mammalia enumerated: quadrumana, vespertilionidae, 314, 315; insectivora, marsupialia, 315; carnivora, 315–317; rodentia, 317, 318; pachydermata, 318–320; ruminantia, 320, 321; cetacea, 326.
Bruniquel, cavern of, and its contents, described, 294–296.
Buckland, Dr., describes the teeth and jaw of the megalosaurus, 199, 200; properties of the plesiosaurus, 210; his account of the pterodactyl, 220, 221; of coral islands, 264.

CAMPBELL, THOMAS, the poet, quoted, 44.

Canis lupus, the, 316.

Carnivora, fossil remains of, in Great Britain, 315–317.

Cataclysmal theory of creation, the, unsoundness of, 14–18.

Cave-bear, the, description of, by Carl Vogt, 52–54.

Cave-tiger, the, described, 63, 64; its disappearance from Europe, 311, 312.

Cephalaspes, various species of, 241; general description, 241, 242; pictured by Hugh Miller, 242, 243.

Cephalopoda, the two orders of, 255.

Cetacea, fossil remains of, in Great Britain, 321.

Cervus Bucklandi, the, 320.

Cervus elephus, the, noticed, 320.

Cervus megaceros, the, habitat of, 91; its historical existence conjectured, 92, 93; its appearance described, 94.

Cimoliornis Diomedeus, the, a long-winged bird of the Chalk, 183.

Cenopithecus lemuroides, 33.

Collinson, Mr., on some bone discoveries near the Ohio, 146, 147.

Coral islands, formation of, 263–269.

Correlation of forms, the, principle of, described, 26, 27.

Coryphodon Eocaenus, the, 318.

Creation, a work of continuous development, 14, 17.

Cuvier, his "Discours sur les Révolutions du Globe," quoted, 14, 30; on fossils, 18, 19; founder of paleontological science, 26; his principle of the correlation of forms, 26, 27; on fossil apes, 30; on the mastodon, 150, 151; on the antiquity of man, 276–278.

Cyclophthalmus Bucklandii, the, 249.

DARWIN, on the life-work of the ocean animalcules, 264, 267.

Dinotherium, the, remains of, described, 166, 167; theories concerning, 168; descriptive details of, 171, 172; marsupial bones in, 172; an aplacentary animal, 173.

Desnoyers, M., his description of the megaceros carnutorum, 280.

Dinornis, the, signification of the word, 186; identical with the moa, 186; gradual discovery of the bones of, 187; Hochstetter's successful researches, 187–189; the dinornis elephantopus, 190; the dinornis giganteus, 190; its disappearance has taken place recently, 312; was formerly hunted by the Maoris, 312.

D'Orbigny, Alcide, his "Cours de Paléontologie," quoted, 14; his theory of the creative process, 17; remarks on fossils, 19; on Chinese superstitions respecting the mammoth, 164.

Douglas, bishop of Dunkeld, 243, 244.

Dodo, the, disappearance of, from the Mauritius, 313; its recent total extinction, 313.

EARTH, the, various strata of, 47, 48; species of organic beings belonging to them, 49.

Edentata, the, general peculiarities of, 70; the two orders, tardigrada and effodentia, 70.

Ehrenberg, his discoveries in the composition of chalk, 15.

Elephant, the.—*See* MAMMOTH.

Elk, Irish, the.—*See* CERVUS MEGACEROS.

Eopithecus, 32.

Epiornis, the, discovered at Madagascar, 191; its enormous eggs and general size, 192; scanty materials for reconstruction of, 193.

Equus fossilis, the, 319.

Eurypterus remipes, the, 253.

Eyzies, the grotto of the, contents of, 293, 294.

FELIS SPELAEA, the, 317.

Fishes, fossil, four orders of, distinguished by Agassiz, 237, 238; their points of similarity with the embryos of existing fishes, 246, 247.

GANOIDS, the, general characteristics of, 238.

Garrigou, Dr., on the antiquity of man, 279.

Gastornis Parisiensis, the, fossil of, discovered, 184; described, 185; its antiquity, 186.

Gaudry, his "Animaux Fossiles," quoted, on the subject of fossil apes, 31, 32; his examination of the mesopithecus, 34–40.

Geology, the various schools of, and their disciples, 313.

Geologist, the, his work in reviewing the ancient world, 46.

Geological systems, enumerated and described, 50, 51.

Glyptodon, the, description of, 73, 74; its history, 74, 75; the two species, glyptodon clavipes and glyptodon ornatus, 75–77.

Gulo primigenius, identical with the metarctos, 56.

HALCYORNIS TOLIAPICUS, the, 184.

Heckel, quoted, 247.

Helladotherium, the, a mammal of ancient Hellas, 100; general descrip-

tion of, 101; further remarks, 102, 103.
Hercules and the Erymanthian boar, legend of, 116.
Herodotus, his description of the lake-dwellings of the Romans, 307.
Hippopotamus major, described by Sir Charles Lyell, 319.
Hipparion, the, a link between the ordinaria and the solidungula, 108; its supposed habits, 109; its appearance described, 109–115.
Hitchcock, Professor, his study of the footprints of the "bird of Massachusetts," 181, 182.
Hochstetter, M., discoveries of, in connection with the dinornis or moa, 187–189.
Home, Sir Everard, his description of the ichthyosaurus, referred to, 208.
Humboldt, on the so-called Eocene formation, 15.
Hystrix primigenius, restoration of, 68, 69.
Hylaeosaurus, the, primitive type of the iguana, 201.
Hyracotherium leporinum, 319.
Hyena, the, as a fossil, in Europe, 59; historical existence and general peculiarities of the hyaena spelaea, 59, 60, 317; remarkable species, 61.
Hyaenictis, the, 62.

ICHTHYOSAURUS, the, description of, 208, 209; particularized as a saurian whale, 209; details of organization of, 210–213; literary notices of it, 213, 214; recent discoveries of, 214; species of, 215.
Ictitherion, the, general characteristics of, 57; the ictitherium robustum, 57, 58; ictitherium hipparionum, 58; ictitherium D'Orbignyi, 58.
Ides, Isbrant, the traveller, discovers the Siberian mammoths, 160, 161; on Asiatic superstitions concerning the mammoth, 163, 164.
Iguanodon, the, dimensions of, 201; comparative size of its bone, 203; its dentition, 203, 204.
Infusoria, the, some facts about, 273, 274.
Insectivora, fossil remains of, in Great Britain, 315.
Insects, in their fossil condition, 248.
Iron, the age of, its various implements enumerated, 309.

KAUP, his theories concerning the dinotherium, 167, 168.
Kitchen-middens, the, of Denmark, as described by Sir John Lubbock, 299, 300.

LAGOMYS SPELAEUS, 318.
Lake-dwellings, first discovery of, 302; in the Lake of Zurich, described, 302–305; at other localities in Switzerland, 305, 306; in New Guinea, 306; amongst the Papuans, 306, 307.
Lartet, M., his discoveries in the Cave of Aurignac, 284-286; his visit to the bone-caves of the Dordogne, 288, 289.
Laurentian rocks, description of, 272, 273.
Leptodon, the, 127.
Lherm, discoveries of fossil bones in the cave of, 54, 55.
Lithornis vulturinus, the, 183, 184.
Lophiodon, the, 124.
Lubbock, Sir John, his "Prehistoric Times," quoted, 59, 93.
Lutra vulgaris, the, 316.

MACACUS PLIOCENUS, 32.
Machairodus cultridens, the largest of the carnaria, 64; its physical structure described, 64; its recent discovery, 65; its past appearance in the Tertiary period, 65, 66; specimens of, in Europe, 66, 67; machairodus latidens, 317.
Macrotherium, how discovered and restored, 71.
Mammoth, the, fossil relics of, 155; its appearance as reconstructed, 156–159; wide range of its habitat, 159; its presence in boreal latitudes, 160, 161; stories of mammoth discoveries, 161–163; superstitions respecting its present existence, 163, 164; how its disappearance may be accounted for, 165; the origin of the word, 166; poetical description of, 166.
Mastodon, the, described by Hugh Miller, 142, 143; two species of, 143; the mastodon augustidens, 143; the mastodon magnum, legends of the supposed size of, 143, 144; where it was found, 145; the mastodon in Kentucky, 145, 146; on the river Ohio, 146, 147; early notices of, 148, 149; Buffon on the subject of the mastodon, 149, 150; Cuvier's description of, 150, 151; recent species discovered, 151, 152; habits of, 152; difficulties in reconstructing it, 153, 154; mastodontal remains in England, 154, 155.
Man, his share in the destruction of species now extinct, 23, 24.
Megaceros carnutorum, the, 280.
Megaceros Hibernicus, the, 320.
Megalonyx, the, description and reconstruction of, 38, 87.
Megatherium, the, described; its fossil

remains, 78; mentioned by Cuvier, 78, 79; description of, continued, 79–82; its habits, 83; its food, 84; its bodily weapons of defence, 84, 85; how first discovered and reconstructed, 85, 86.
Mesopithecus, the, described, 34–40.
Metarctos, characteristics of, 55–57.
Meunier, his "Animaux d'Autrefois," 18.
Miliolites, the, 270, 271.
Miller, Hugh, on the mammals of the Quaternary Period, 93, 94; his description of the mastodon, 142, 143; of the footprints of the "bird of Massachusetts, 181, 182; of the pterichthys, 239–241.
Milton, the poet, quoted, 107, 116, 174, 205, 221.
Moa.—*See* DINORNIS.
Mylodon, the, described, 89.

NEREITES CUMBRIENSIS, the, 250.
"Nibelungen Lied," the, quoted, 92.
Numulites, the, a tribe of the foraminifera, 271; whence the name is derived, 271; where they are met with, 271, 272.

ORGANISM, an, the nature of, 49, 50; difference between animals and plants, 50.
Owen, Professor, "Paleontology" of, quoted, 96; his "British Fossil Mammals and Birds," quoted, 131, 140, 157, 158, 183, [illegible].

PACHADERMATA, the, general features of, 107; divided into three sections or classes, 107; fossil remains of, in Great Britain, 318–320.
Palaeoreas, the, and its sub-genera, 96, 97.
Palaeospulux magnus, the, 315.
Palaeotherium, the, described, 123, 124; its place in geology, 124.
Palaeotragos, the, 99, 100.
Palapteryx ingens, the, description of, 190; reconstructed by Dr. Jaeger, 190, 191.
Paleontology, founded by Cuvier, 26; some of its later results indicated, 28, 29; its mission, the realization of the phenomena of the Primeval World, 46, 47; its four ages, 282.
Paloplotherium, the, Cuvier distinguishes seven species of, 128; paloplotherium Codiciense, a new species, 128; paloploptherium annectens, 129; paloplotherium minus, 129.
Peonians, the, lake-dwellings of, described by Herodotus, 307.
Perthes, M. Boucher de, his theory of the contemporaneous existence of man and the mammoth, 287, 288.
Pictet, M., the French paleontologist, on the want of precise osteological characters, 176.
Placoids, the, general characteristics of, 238.
Plesiosaurus, the, features of, 215, 216; Conybeare's description of, 217; its length of neck, 218; its trunk, 218, 219; Buckland, on its provable faculty of changing colour, 219; characterized by Professor Owen, 220.
Pliopithecus antiquus, 31.
Polypes, the coralline, wonderful works of, described, 262–268; their formation, in some respects, mysterious, 269.
Polynesia, archipelagoes of, the creation of the coralline, 268.
Pope, the poet, quoted, 237.
Protozoa, the divisions of, 270, 271.
Pterichthys, the, discovered in the Old Red Sandstone, and described by Hugh Miller, 239–241.
Pterodactyl, the, described by Dr. Buckland, 220, 221; origin of its name, 221; its size, 221; localities where found, 222; singular feature, 222; characterized by St. Vincent, 223, 224; Cuvier and Buckland on its organization, 224; its insectivorous habit, 224; different descriptions of, 225–227.
Pterygotus bilobatus, the, 252, 253.
Putorius vulgaris, the, 316.

QUADRUMANA, fossil remains of, in Great Britain, 314.
Quatrefages, M. de, on evidences of the existence of primitive man in Scandinavia, 321–328.

RADIATA, the, importance of, in creation, 262; how they assist in the formation of coral reefs, 263, 264.
Rafn, his "Antiquitates Americanae," quoted, 327.
Ramphorynchus, the, a winged saurian, 227, 228.
Ray, John, his "Wisdom of God manifested in the Works of Creation," quoted, 262.
Rhinoceros pachygnatus, the, Gaudry's reconstruction of, 130; structure and organization, 131.
Rhinoceros tichorhinus, discovered at Chartham in Kent, 132; Mr. Somner's narrative, 132–135; its characteristics indicated, 136; remarkable fossil specimen from Russia, 136–138; description of, 139, 140; inhabited Arctic regions, 140, 141.

Rhynchosaurus, the, 207, 208.
Rodentia, the, fossil remains of, in Great Britain, 317, 318.
Ruminantia, the, habits and structural peculiarities of, 90, 91; British fossil remains of, 320, 321.

Saint-Fond, Faujas de, his seizure of the mosasaurus at Maestricht, 205; refuted by Cuvier, 206.
Saint-Hilaire, Geoffroy, his views on the progress of paleontology, 28; on the galidia, 63.
Saint-Priest, sand-beds of, and their bone deposits, 280, 281.
Sandstone, Old Red, a list of the genera and species of fish discovered in, 244-246.
Saryschew, Gabriel, his discovery of a mammoth in Siberia, 161, 162.
Saurians, vestiges of the primeval, 197.
Scandinavia, pre-historic man in, 321-328.
Sedgwick, Professor, quoted, 43.
Semnopithecus monspessulanus, 32.
Siberia, mammoth remains in, 160, 161.
Sivatherium, the, discovery of, 94; description of the organization of, 94-96.
Somner, Mr., of Kent, his discovery and quaint description of a fossil tichorhinus, 131-135.
Sponges, the, Sir Charles Lyell's hypothesis concerning, 275.

Tarso-metatarsus, the, of the bird, its importance as a means of classification, 177, 178.
Teleosaurus, the, as described by Saint-Hilaire and Deslonchamps, 198.
Tennyson, the poet, his "In Memoriam" quoted, 196.
Thomson, James, the poet, quoted, 248.
Tragoceros, the, a link between the antelope and the goat, 98, 99.
Trigontherium Cuvieri, the, 317.
Trilobites, the, where most abundant, 250; their physical characteristics, 250, 251.

Ursus spelaeus, ursus arctoides, ursus leodiensis, and ursus priscus, described, 52, 53.

Vespertilionidae, fossil remains of the, in Britain, 314, 315.

Wading-bird, a, discovery of, in the order grallatores, 184.
Worms, fossil, 249, 250.
Worsaee, his "Antiquities of South Jutland or Sleswick," quoted, 325, 326.

Young, Dr., the poet, his description of "the behemoth," 166.